

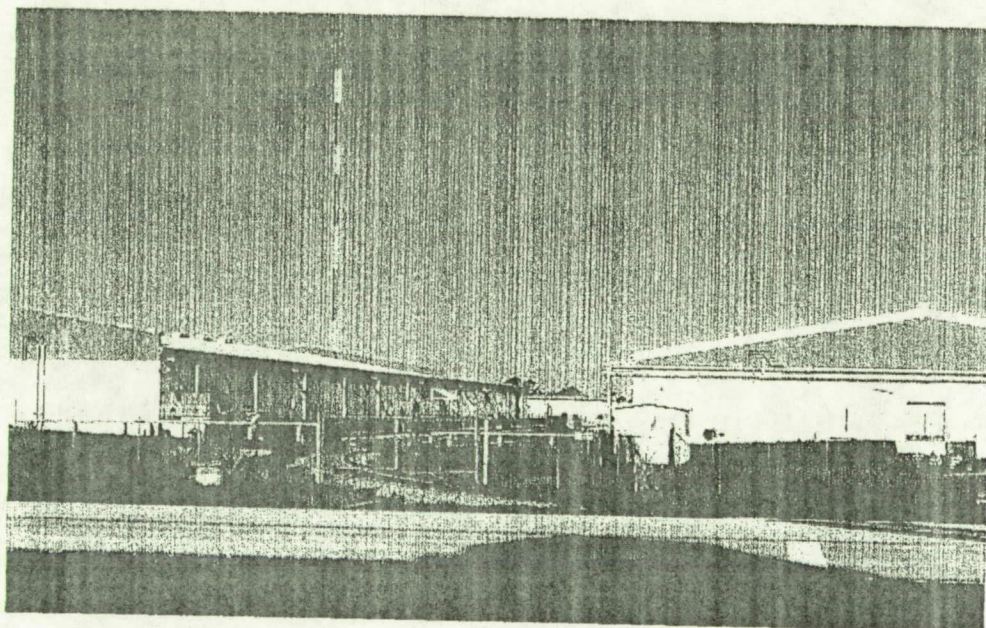
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# Investigation of the Building M6-794 Roofing Fatality Type A Mishap

Mishap Report  
May 2006



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## FOREWORD

The Building M6-794 Roofing Fatality Mishap Investigation Board (Board) was commissioned to gather information; analyze the facts; identify the proximate causes, root causes, and contributing factors relating to the mishap; and recommend appropriate actions to prevent a similar mishap from occurring in the future. During the investigation of this mishap, the Board also examined the fall protection policies of other NASA Centers and operating locations to gain an understanding of how those entities conduct fall protection, as well as the degree to which fall protection is standardized across the Agency.

### ACKNOWLEDGEMENTS

The Board wishes to thank the workers of Space Gateway Support, Oneida Construction, Inc., and NASA at Kennedy Space Center for their cooperative support throughout the investigation.

The Board gratefully acknowledges the contributions made by the following individuals and organizations from KSC: Maxine Cherry and Lisa Singleton (SA-A1, NASA/KSC) for administrative support; Tim Fletcher (InDyne, Inc.) and Bob Tabin (Lockheed Martin/ODIN) for IT support; Tim Adams (EA-C, NASA/KSC) for Relex support; Dave Barker, Bob Preston, and Tom Dwyer (SA-E2, NASA/KSC) for safety support; Deborah Doxey (ASRC Aerospace) for technical writing; and Richard Beard (InDyne, Inc.), Caroline Zaffery, and Alex Taylor (ASRC Aerospace) for graphics support. In addition, the Board acknowledges Guiseppina Ancona (Ryan Reporting) for court reporting; and Faith Chandler, NASA Headquarters.

The results of their efforts proved crucial to the success of this investigation.

## EXECUTIVE SUMMARY

### *The Mishap*

On March 17, 2006, at approximately 1325 EST, a construction worker fell from the roof of Supply Warehouse #1 (Building M6-794) in the Kennedy Space Center (KSC) Industrial Area. Rescue personnel arrived at the mishap scene minutes later, and the worker was subsequently airlifted to the Orlando Regional Medical Center. He died 1606 EST that same day as a result of head injuries. The deceased and other roof workers involved were all employed by Oneida Construction, Inc. At the time of the mishap, the workers were installing a corrugated metal roofing panel as part of Subcontract X04524-6, awarded to Oneida through the Space Gateway Support, LLC (SGS), Subcontracts Administration Office.

Based on a mishap site visit, interviews, and data analysis, the Mishap Investigation Board (Board) identified the underlying causes of the mishap. Event and causal-factor tree diagrams were developed, resulting in the identification of proximate (or direct) causes and root causes of the mishap.

### *Proximate Causes*

Two proximate causes of this fatality were identified. If either of these were eliminated or modified, this mishap would not have occurred.

- **Proximate Cause 1: The deceased was working close to the edge of a roof (17 feet above the ground) without proper fall protection.** The roofing work should have been classified as steel erection, for which the Occupational Health and Safety Administration (OSHA) required physical restraints. However, Oneida and SGS misclassified the roof work as low-sloped roofing, which did not require physical restraints. For low-sloped roofing work, OSHA allowed use of a Warning Line and Safety Monitoring System in lieu of physical restraints. A warning line was not used and the safety monitor was helping the other workers instead of acting solely as a safety monitor; both were violations of OSHA regulations for proper fall protection.
  - **Contributing Factor (CoF-1):** Superintendent helped move the roofing panel while acting as the safety monitor.
  - **Contributing Factor (CoF-2):** Superintendent did not stop the job and seek additional personnel when two workers were not sufficient.
  - **Contributing Factor (CoF-3):** Temporary anchorage points were not required by OSHA, NASA, KSC, or contractors.
- **Proximate Cause 2: The deceased fell from the roof.** Evidence shows that the deceased either tripped or stumbled prior to falling off the roof, rather than stepped off the roof. The two most likely tripping hazards were the lightning

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protection wire (located approximately 6 inches from the edge of the roof) and the uneven working surface of the corrugated roof.

- **Contributing Factor (CoF-4):** While not legally intoxicated under Florida's Driving Standard, the deceased was under the influence of alcohol and tested positive for marijuana.

*Root Causes and Recommendations*

Subsection 4.2 of this report contains recommendations related to root causes that, if followed, should prevent similar mishaps from occurring in the future. The root causes and recommendations were as follows:

**Root Cause 1: Oneida was unaware of the OSHA interpretation to classify the work as steel erection (RC1),** which required a physical restraint instead of the Warning Line and Safety Monitoring System.

**Recommendation (RC1-1):** When responding to a Request for Proposal (RFP) and prior to preparing a safety plan, subcontractors should review OSHA regulations and letters of Standard Interpretation to properly classify the work.

- When roofing jobs are performed, subcontractors are responsible for determining the applicability of 29 CFR 1926.501 (low-sloped roof) and 29 CFR 1926.750 (steel erection) in accordance with OSHA Standards and letters of Standard Interpretation.
- Contract language should include information alerting subcontractors that the OSHA Area Office has a compliance assistance specialist available as a resource.

**Root Cause 2: SGS was unaware of the OSHA interpretation to classify the work as steel erection (RC2).**

**Recommendation (RC2-1):** Prior to issuing an RFP, the prime contractor should review OSHA Standards and letters of Standard Interpretations to properly classify work.

**Recommendation (RC2-2):** NASA/KSC and prime contractors should review current ongoing work involving roofing to ensure proper work classification and compliance with OSHA Standards and letters of Standard Interpretation.

**Root Cause 3: Oneida did not ensure its superintendent's compliance with the OSHA requirement for fall protection (RC3).** Although SGS had previously written up the superintendent for warning line and safety monitor noncompliances, the Board had no evidence that these noncompliances were ever presented to the Oneida owner/president.



**Recommendation (RC3-1):** Prime contractors should develop a mechanism to ensure that OSHA noncompliances immediately dangerous to life and health are reported to the subcontractor president/top management.

**Root Cause 4: SGS did not ensure Oneida's compliance with the OSHA requirement for fall protection (RC4).** Although SGS had previously written up the superintendent for warning line and safety monitor noncompliances, the noncompliances were corrected on the spot and no further retraining, corrective action, or disciplinary action was taken by Oneida toward the superintendent or by SGS toward Oneida.

**Recommendation (RC4-1):** SGS should develop a mechanism to ensure that OSHA noncompliances immediately dangerous to life and health are reported to the subcontractor president/top management.

- Other prime contractors (e.g., United Space Alliance and Boeing) should develop a similar mechanism to ensure that OSHA noncompliances immediately dangerous to life and health are reported to the subcontractor president/top management.
- For construction contracts that NASA/KSC issues, NASA/KSC should develop a similar mechanism to ensure that OSHA noncompliances immediately dangerous to life and health are reported to the contractor president/top management.

**Recommendation (RC4-2):** Prime contractor safety specialists should trend noncompliances and discuss them at the appropriate contractor/subcontractor safety meeting.

**Recommendation (RC4-3):** For construction contracts that NASA/KSC issues, NASA/KSC should trend noncompliances and discuss them at the appropriate contractor safety meeting.

**Root Cause 5: NASA/KSC fall protection practices follow the OSHA-defined standards for low-sloped roofs, which allow the Warning Line and Safety Monitoring System rather than requiring a physical-restraint system (RC5).**

**Recommendation (RC5-1):** NASA/KSC should develop and implement a fall protection policy and program for low-sloped roofing work that is more stringent than the applicable OSHA standard and requires the use of physical restraints when working within 6 feet of the edge. The use of warning lines and safety monitors or other nonphysical-restraint systems should be reserved for special circumstances after review and approval through a NASA/KSC formalized variance process.

**Recommendation (RC5-2):** A Centerwide fall protection team (civil servants and contractors) should be formed to examine issues (e.g., standardization across contractors, variance processing, retrofitting of existing facilities) arising from the implementation of a new, more stringent fall protection policy and program.

Building M6-794 Roofing Fatality  
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*Other Significant Observations*

The significant observations are in subsection 4.5 and fell into several groupings:

**Training and Documentation:**

- **Observation (O-1):** Oneida did not maintain a current list of employees who were working on the job site.
- **Observation (O-2):** Oneida did not conduct, or did not document, all weekly safety meetings.
- **Observation (O-3):** Oneida provided no evidence that either the deceased or the other Oneida worker was trained by a competent person qualified in 29 CFR 1926, Subpart M, Fall Protection. Therefore, the training of the deceased and the other Oneida worker was deficient.
- **Observation (O-4):** The training certification provided by Oneida was not signed by the trainer or the employer, so it was in technical violation of 29 CFR 1926.503(b)(1).
- **Observation (O-5):** While KSC fall protection training was, for the most part, adequate for construction workers, it was insufficient for specialized training for competent or qualified persons and inspector training.

**Communication:**

- **Observation (O-6):** Contractors and subcontractors were not required to inform NASA of all on-Center worksite OSHA noncompliances.
- **Observation (O-7):** Inadequate coordination within SGS resulted in Oneida working without the knowledge of SGS Safety.

**Fall Policy:**

- **Observation (O-8):** Permanent anchorage points were not added anytime after the initial construction of Building M6-794, and KSC policy did not require their installation.
- **Observation (O-9):** Other than OSHA minimum standards, no single, standardized fall protection policy exists across all NASA Centers or operating locations.

**Other:**

- **Observation (O-10):** Drug and alcohol testing was not performed on Oneida workers involved in the mishap.

- **Observation (O-11):** Contract clause flowdown to the subcontractor was not a contributing factor to the mishap.
- **Observation (O-12):** Behaviors identified in mishaps can be used to study and improve the KSC safety culture.

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INVESTIGATION OF THE  
BUILDING M6-794 ROOFING FATALITY  
TYPE A MISHAP

1. CHARTER AND RESPONSE

1.1 Transmittal Letter

National Aeronautics and  
Space Administration  
John F. Kennedy Space Center  
Kennedy Space Center, FL 32899



May 11, 2006

Reply to Attn of:

SA

TO: AA/Director

FROM: Chairman, M6-0794 Roofing Fatality Mishap Investigation Board

SUBJECT: Final Report for Building M6-0794 Roofing Fatality

Reference your letter dated March 24, 2006, which established the Mishap Investigation Board for Building M6-0794 Roofing Fatality, March 17, 2006, and defined the Board's responsibilities.

The investigation was conducted in accordance with NPR 8621.1A, "NASA Procedural Requirements for Mishap Reporting, Investigating, and Reporting." The final report of the Mishap Investigation Board's activities, findings, and recommendations is submitted and enclosed.

A handwritten signature in black ink, appearing to read "John H. Casper".  
John H. Casper

2 Enclosures

1. Written Report

2. Electronic Files of Written Report

Comment [m1]: Debby, can you  
make this a little larger? (Low Priority)

Building M6-794 Roofing Fatality  
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1.2 Appointment Letters

The original appointment letter and a subsequent revision memorandum are included here for reference.

National Aeronautics and  
Space Administration  
John F. Kennedy Space Center  
Kennedy Space Center, FL 32899



March 24, 2006

Reply to Act 31: SA

TO: Distribution  
FROM: AA/Director  
SUBJECT: Mishap Investigation Board (MIB) for Building M6-0794 Roofing Fatality,  
March 17, 2006

This memorandum, in accordance with NASA Procedural Requirements (NPR) 8621.1A, "NASA Procedural Requirements for Mishap Reporting, Investigating, and Recordkeeping," establishes the Building M6-0794 Roofing Fatality MIB and sets forth its responsibilities and membership. The chairperson and members of the Board are listed in the enclosure.

In accordance with the NPR, I am establishing the Building M6-0794 Roofing Fatality MIB to gather information; analyze the facts; identify the proximate cause(s), root cause(s), and contributing factors relating to the mishap; and to recommend appropriate actions to prevent a similar mishap from occurring again.

The Chairperson of the Board will report to me on all aspects regarding this investigation.

The Board will:


- Obtain and analyze whatever evidence, facts, and opinions it considers relevant.
- Conduct tests and any other activity it deems appropriate.
- Interview witnesses and receive statements from witnesses.
- Impound property, equipment, and records as considered necessary.
- Determine the proximate cause(s), root cause(s), and contributing factors relating to the mishap.
- Develop recommendations to prevent similar mishaps.
- Provide a final written report that will conform to all requirements in NPR 8621.1.

The Chairperson will:

- Conduct Board activities in accordance with the requirements in NPR 8621.1.
- Establish and document, as necessary, rules and procedures for organizing and operating the Board, including any subgroups, and for the format and content of oral or written reports to and by the Board.
- Designate any additional representatives, advisors, consultants, experts, liaison officers, or other individuals who may be required to support the activities of the Board and define the duties and responsibilities of those persons.
- Designate another voting member of the Board to act as chairperson in his or her absence.
- Document meetings and retain records.

The Board will convene starting the week of March 20, 2006, and will provide a final report within 75 workdays.

I will dismiss the Board when it has fulfilled its requirements.

  
For James W. Kennedy

Enclosure

Distribution:  
See page 3

Building M6-794 Roofing Fatality  
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Mishap Investigation Board  
for the  
Building M6-0794 Roofing Fatality  
Mishap Date: March 17, 2006

The following individuals are the voting members of the MIB:

Name	Organization	Responsibility on Board
John Casper	MG (Johnson Space Center)	Chairperson-Member
C. P. Bennardo	DX-G	Member
David Tipton	TA-C2	Occupational Health Physician-Member
Darcy Miller	SA-B1	Human Factors-Member
Kristie French	QD50 (Marshall Space Flight Center)	Safety-Member

The following individual will serve as the Ex Officio on the MIB, and complete applicable tasks as outlined in NPR 8621.1:

Name	Organization	Responsibility on Board
Facemire, David	SA-E2	Ex Officio

The following individuals are considered support staff to the Mishap Investigation Board:

Name	Organization	Responsibility on Board
Steven Hom	CC	Legal Advisor
Bruce Buckingham	XA-E	Public Affairs Advisor
Mitch Colvin	OP-MS	NASA Contracts Advisor



National Aeronautics and  
Space Administration  
John F. Kennedy Space Center  
Kennedy Space Center, FL 32899



March 28, 2006

Reply to Attn of:

SA

TO: HQ/Chief Safety and Mission Assurance Officer  
AA/Director

FROM: SA/Chairman, M6-094 Roofing Fatality Mishap Investigation Board (MIB)

SUBJECT: Appointment of Additional MIB Representative

Reference: Original Appointment Letter: MIB for M6-0794 Roofing  
Fatality, March 17, 2006

Effective this date, the following person is appointed Advisor to the M6-0794 Roofing  
Fatality MIB:

<u>Name</u>	<u>Organization</u>	<u>Responsibility on Board</u>
Michael Hulet	JSC OSMA	Advisor

A handwritten signature in black ink, appearing to read "John H. Casper".

John H. Casper

cc:

CC/S. Horn	SA-E2/D. Facemire
DX-G/P. Bennardo	TA-C2/D. Tipton
OP-MS/M. Colvin	XA-E/B. Buckingham
SA-A1/M. Cherry	HQ/Office of Safety and Mission Assurance/Safety and
SA-B1/D. Miller	Assurance Requirements Division/F. Chandler
SA-E/B. Preston	JSC/NA/M. Hulet
SA-E2/D. Barker	MSFC/QD50/K. French
SA-E2/J. Brand	PAFB/43SW/SEG/C. Olesnevič
SA-E2/T. Dwyer	

Building M6-794 Roofing Fatality  
Type A Mishap

National Aeronautics and  
Space Administration  
John F. Kennedy Space Center  
Kennedy Space Center, FL 32899



April 19, 2006

Reply to Attn of:

SA

Scott Hampton  
Senior Structural Engineer  
Space Gateway Support  
Mail Code: SGS-127  
Kennedy Space Center, FL 32899

Dear Mr. Hampton:

In accordance with NASA Procedural Requirements (NPR) 8621.1A, NASA Procedural Requirements for Mishap Reporting, Investigation, and Recordkeeping, and the Kennedy Space Center Director's letter dated March 24, 2006, you are hereby appointed as a consultant to the M6-0794 Roofing Fatality Mishap Investigation Board (MIB).

As a consultant to the MIB, you may be called upon to gather information, provide advice, perform analysis, and assist in formulating conclusions. Your role shall not include participating in deliberations; voting on findings; signing the mishap report; or reading, listening to, or participating in witness interviews.

Sincerely,

A handwritten signature in black ink that reads "John Casper". The signature is written in a cursive, flowing style.

John Casper  
Chairman  
M6-0794 Roofing Fatality Mishap Investigation Board

cc:  
HQ/Chief Safety and Mission Assurance Officer/B. O'Connor  
HQ/Office of Safety and Mission Assurance/Safety and Assurance Division/F. Chandler  
JSC/NA/M. Hulet  
MSFC/QD50/K. French

1.3 Signatures Pages

Concurrence by Board Members:

---

John H. Casper  
Chairperson  
MG/Johnson Space Center

---

C.P. Bennardo  
Voting Member, Engineering  
DX-G/Kennedy Space Center

---

Kristie French  
Deputy Chairperson  
Voting Member, Safety  
QD50/Marshall Space Flight Center

---

Darcy H. Miller  
Voting Member, Human Factors  
SA-B1/Kennedy Space Center

---

David A. Tipton  
Voting Member, Occupational Health  
Physician  
TA-C2/Kennedy Space Center

Concurrence by Ex-Officio Board  
Member:

---

David L. Facemire, Safety  
SA-E2/Kennedy Space Center

Building M6-794 Roofing Fatality  
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**Concurrence by Board Advisors:**

---

Michael W. Hulet, Safety  
NA/Johnson Space Center

---

Steven G. Horn, Legal  
CC/Kennedy Space Center

---

Roy M. Colvin, NASA Contracts  
OP-MS/Kennedy Space Center

---

Bruce Buckingham, Public Affairs  
XA-E/Kennedy Space Center

The Board's consultants were

Charles D. Barker, Safety  
SA-E2/Kennedy Space Center

John D. Brand, Safety  
SA-E2/Kennedy Space Center

Thomas P. Dwyer, Safety  
SA-E2/Kennedy Space Center

Robert A. Preston, Safety  
SA-E2/Kennedy Space Center

Scott Hampton, SGS Mishap Board  
Space Gateway Support

The Board's observer was

Chris Olesnevich, Safety  
45<sup>th</sup> Space Wing  
Cape Canaveral Air Force Station  
Patrick Air Force Base

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## **2. MISHAP DESCRIPTION**

### **2.1 Summary**

On March 17, 2006, at approximately 1325 (all times are Eastern Standard Time [EST]), a construction worker fell from the roof of Supply Warehouse #1 (Building M6-794) in the Kennedy Space Center (KSC) Industrial Area. Rescue personnel arrived at the mishap scene minutes later, and the worker was eventually airlifted to the Orlando Regional Medical Center (ORMC). He died later that same day, as a result of head injuries sustained during the fall. The workers were all employed by Oneida Construction, Inc. At the time of the mishap, the deceased and two other Oneida employees were installing a corrugated metal roofing panel on the northeast corner of the roof. This work was being performed as part of Subcontract X04524-6, awarded to Oneida through the Space Gateway Support, LLC (SGS), Subcontracts Administration Office.

### **2.2 General Events Before the Mishap**

Building M6-794, built in 1965, is a warehouse located in the KSC Industrial Area used to store Boeing flight equipment. On September 15, 2005, Subcontract X04524-6 was awarded to Oneida Construction, Inc., through the SGS Subcontracts Administration Office, to make repairs to the existing M6-794 metal roofing system. The roof of Building M6-794 has a slope of 2:12 (vertical rise:horizontal distance), which falls under OSHA's definition of a low-sloped roof (OSHA 29 CFR 1926.500(b)). (The roofing work was misclassified as low-sloped roofing but should have been classified as "steel erection" because replacement of metal roof panels is steel erection as covered by 29 CFR 1926.750(b)(1)). The edge of the roof is approximately 17 feet (ft) above the surrounding concrete loading dock and 10 ft above an air-handling unit near the northeast corner of the building.

A limited Notice to Proceed was issued at a prework conference held on September 15, 2005, which allowed the contractor to begin ordering materials.

Oneida submitted a safety plan that addressed fall protection and worker training and certification on September 19, 2005. This plan was approved by the SGS Safety, Health, and Training Office on September 23, 2005. Full Notice to Proceed was also issued on September 23, 2005. Oneida initially delivered materials to the job site on November 11, 2005, and began actual site work (replacement of roofing panel fasteners) on November 14, 2005.

Sometime after site work began, technical questions arose regarding fasteners used to secure the metal panels to the roof, and Oneida submitted a Request for Information (RFI) to SGS. All site work stopped on December 12, 2005, because this RFI was still unresolved when SGS officially issued a Stop Work Letter.

Answers to the fastener-related technical questions submitted by Oneida were eventually provided by SGS, and on March 15, 2006, the SGS subcontract administrator gave verbal direction to Oneida to resume site work.

During the morning of March 16, 2005, at a regularly scheduled weekly safety meeting, Oneida gave its employees a safety briefing, using materials from the KSC Safety Standdown. (The KSC Safety Standdown was planned to occur later that same day.)

### 2.3 Specific Events of the Day of the Mishap

On March 17, 2006, at approximately 0800, a crew of three (two workers and a superintendent) employed by Oneida arrived at Building M6-794 to resume work on the roof. This was the first time Oneida had been on this job site in several weeks. An informal work discussion was held, and there was a delay in the actual start of the work while the crew waited for an aerial lift to be delivered to the job site. The aerial lift was needed to safely transport materials to the roof and accomplish some of the roofing panel installations.

At approximately 1015, the aerial lift arrived and the crew began replacing three sheet metal roofing panels. Initially they replaced a panel on the northwest corner of the roof, with two of the three crew members working from the aerial lift, and one crew member working from the roof. Next they began replacing a panel on the southeast corner. This work was performed with all three crew members working from the roof because an existing parapet wall that projected 37 inches above the surface of the roof interfered with the use of the aerial lift. While they worked from the roof, the only means of fall protection used by the crew was the Safety Monitoring System. According to OSHA 29 CFR 1926.502(h)(1)(ii), safety monitors are intended to warn the employee when it appears that the employee is unaware of a fall hazard or is acting in an unsafe manner. According to OSHA 29 CFR 1926.501(b)(10), safety monitoring alone is allowed without a Warning Line System on roofs less than 50 ft wide; however, the roof of Building M6-794 is wider than 50 ft. At that time, the superintendent also assumed the role of safety monitor. The second panel was replaced before lunch, except for installing a few remaining fasteners.

The crew stopped work for lunch, and Workers 1 (deceased) and 2 left the job site. The superintendent did not accompany the two workers. At approximately 1310, the same crew of three returned to the job site and resumed work. The crew finished installing the remaining fasteners on the second roofing panel (southeast corner of the roof) and then began installing a third (final) metal roofing panel. This third panel was located on the northeast corner of the roof, adjacent to the edge. Work on this third panel was also performed from the roof because of limited access by the aerial lift. The superintendent determined that interference with existing railroad tracks and an air-conditioning unit would preclude use of the aerial lift platform to replace this third panel and that the crew would continue to work on the roof using the Safety Monitoring System as their only means of fall protection. While working on the northeast corner of the roof, the superintendent continued in his secondary role as safety monitor. In addition to the dual roles of superintendent and safety monitor, this individual was also actively involved in replacing the third roofing panel, in direct violation of OSHA 29 CFR 1926.502(h)(1)(v) requirements. The crew encountered some interference between the third roofing panel and an existing lightning protection wire, which ran approximately 6 inches from the roof leading edge. As a result, the superintendent unsecured a portion of this wire from its existing roof guide brackets (to facilitate removal and replacement of the final panel). During installation of the final panel, Worker 2 lifted the edge of an existing panel to allow the new panel to be slid underneath. The superintendent/safety monitor and Worker 1 moved to the new panel, which was lying

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parallel to the roof edge. The superintendent/safety monitor (Worker 3) then picked up the uphill end of the new panel, while Worker 1 (deceased) picked up the downhill end. Together they began to carry the new panel into its final position, rotating it perpendicular to the roof edge. Worker 1 was located closest to the leading edge of the roof and walked with the panel toward the edge, while the superintendent/safety monitor acted as a pivot point, holding his end of the panel (see Figure 1).

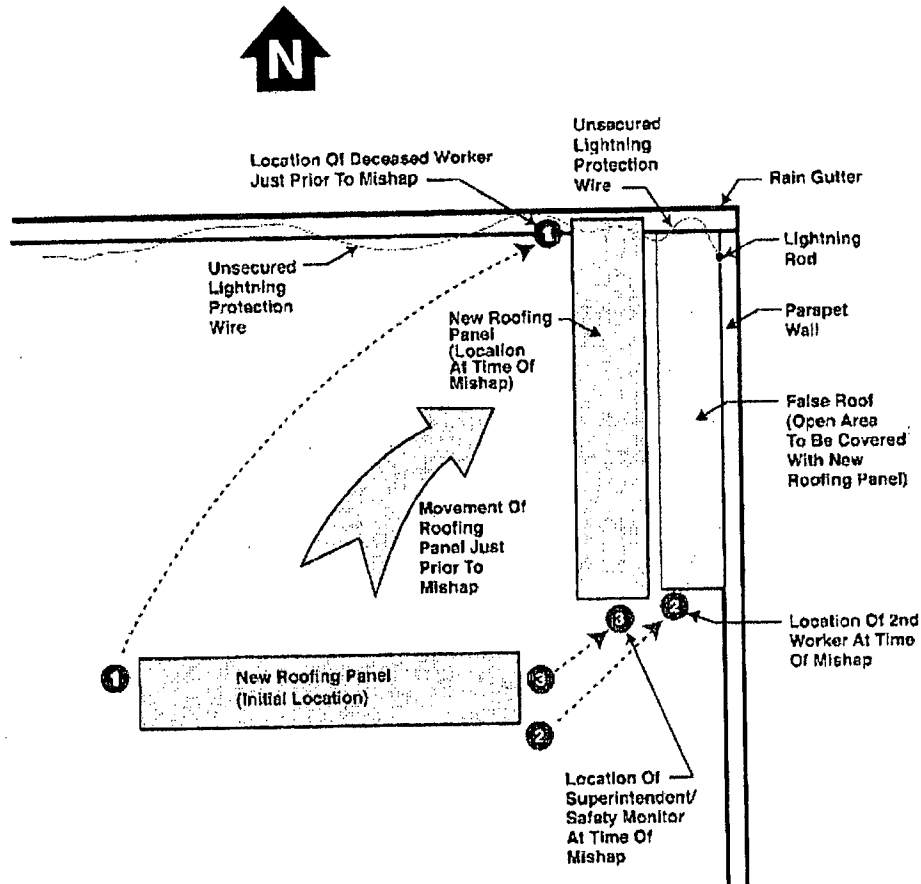


Figure 1. Plan (Bird's Eye) View of Northeast Corner of Building M6-794  
(Mishap Location)

At approximately 1325, Worker 1 lost his footing, let go of the new roofing panel, and fell from the roof. He fell backward approximately 10 ft, his head struck an air-conditioning unit, and he then fell an additional 7 ft to a concrete loading dock.



The lightning protection wire was unsecured at the edge of the roof and posed a tripping hazard. The Board could not determine with certainty whether Worker 1 tripped on the lightning protection wire or on something else (e.g., corrugations in the roofing panels), or if he stumbled and the lightning protection wire prevented him from regaining his balance and he subsequently fell from the roof.

Details of the mishap scene are shown in Figure 2, Figure 3, and Figure 4.

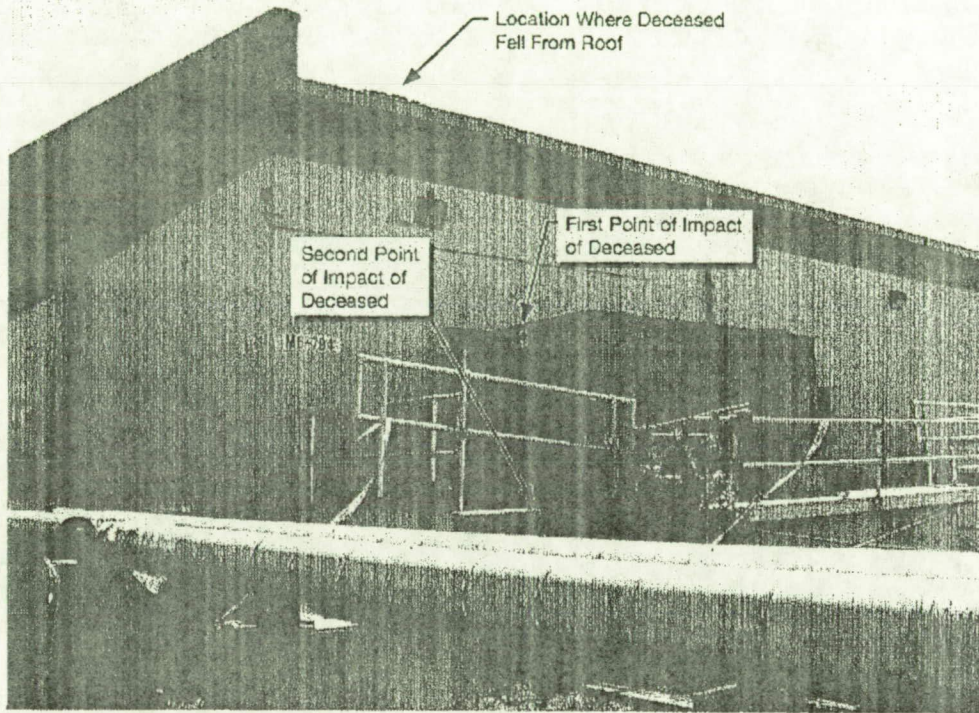


Figure 2. Mishap Site



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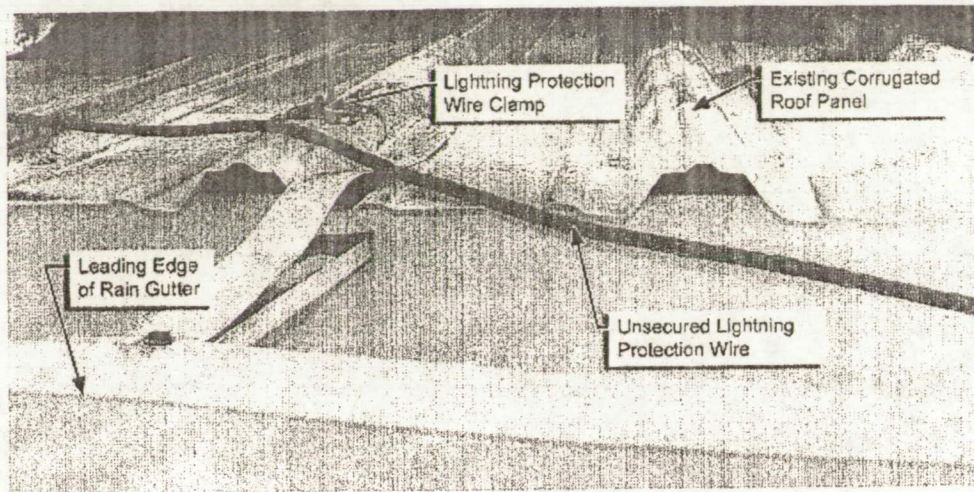


Figure 3. Close-up View of Leading Edge of Roof at Point Where the Deceased Fell



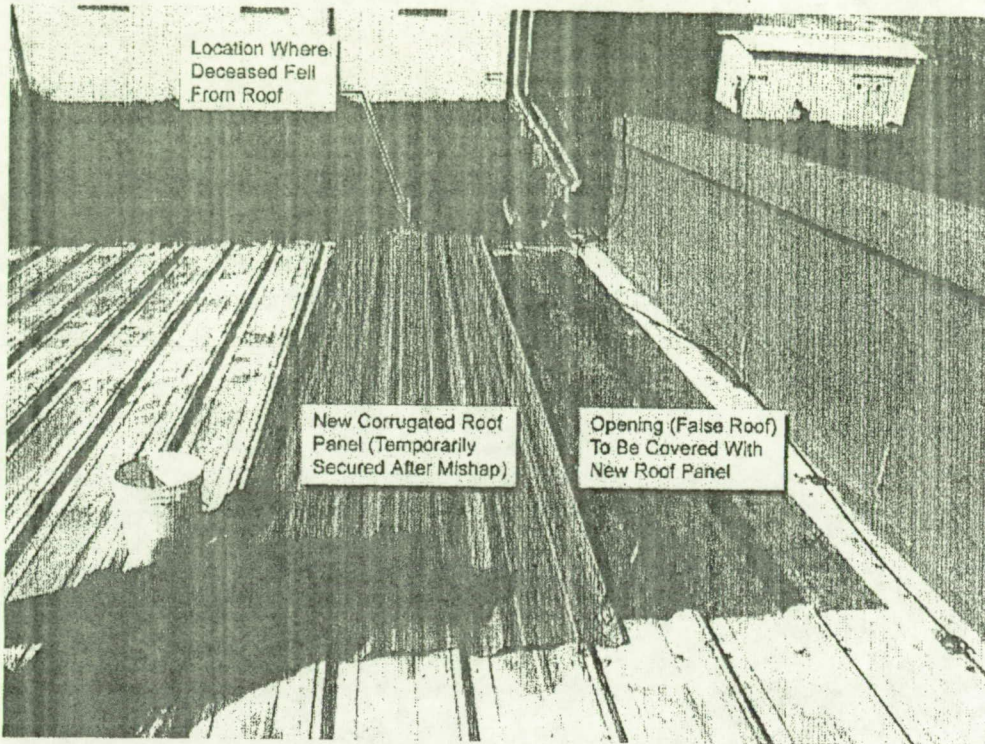


Figure 4. View of Mishap Location From Roof

Subsequent to the mishap, the Board noticed damage to the rain gutter, near the location of the fall, with outward bending of the upper rim of the gutter in particular. The Board concluded that the deceased most likely contacted the gutter as he fell from the roof. This gutter damage can be seen in Figure 3.

The mishap was witnessed by an SGS logistics coordinator standing on a first-floor exterior landing (approximately 4 ft high), on the south side of Building M6-744, approximately 200 ft northwest of the scene of the mishap (see Figure 5). At the time of the mishap, the sun was directly overhead and did not appear to interfere with the line of sight of the witness. The witness called 911 within seconds of observing the mishap.

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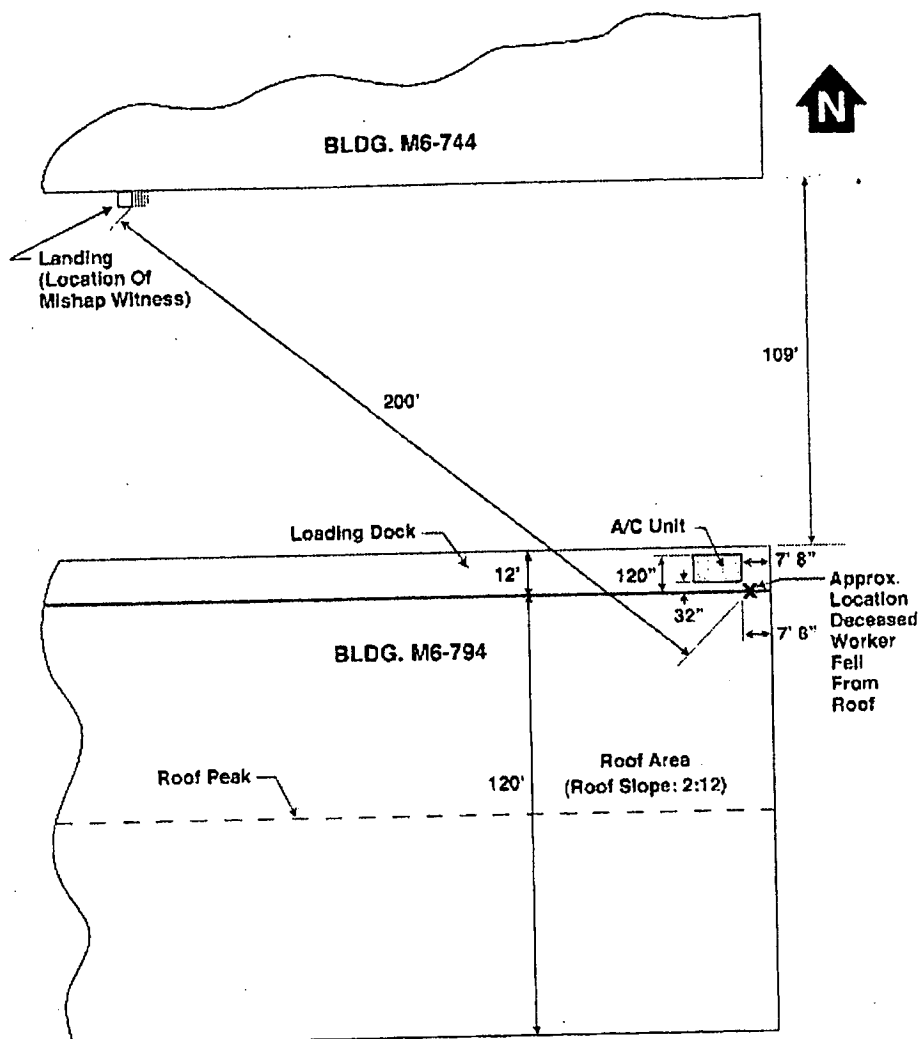


Figure 5. Location of Mishap Witness Relative to Mishap Site

#### 2.4 Emergency Response

The 911 call was received at 1325, and Fire/Rescue (F/R) and Emergency Medical Services (EMS) were dispatched at 1327. F/R and EMS arrived on the scene at 1328. First contact with and initial assessment of the patient occurred at 1329.

F/R immediately requested helicopter transport, a second F/R ladder truck, and a second ambulance, while the EMS paramedics continued to assess and began to treat the patient.

At 1331, Dispatch learned that First Flight (the Holmes Regional Medical Center helicopter medevac) was not available, and in accordance with protocol, called in Air Care (the ORMC helicopter medevac).

The EMS paramedics continued to assess, treat, and try to stabilize the patient. They were joined by the second ambulance crew at about 1335. Initially, the patient was breathing spontaneously, but after receiving preparation for intubation, he required artificial ventilation. His heart was monitored, he was given intravenous fluids, and his spine was stabilized with a cervical collar and a backboard.

The medical director of the KSC Occupational Health Facility arrived on the scene about 1340 and helped the paramedics assess and treat the patient.

A NASA safety specialist arrived on the scene at about 1350 and took control of the scene as the lead for the Incident Response Team (IRT).

The Air Care medevac helicopter arrived on the scene at 1356. The patient was carried to the medevac helicopter at 1405. The helicopter departed for ORMC at 1410 and arrived at ORMC at about 1428.

Evaluation and treatment of the patient continued at ORMC. However, the medical staff could not save his life, and the patient was pronounced dead at 1606.

## **2.5 Events After the Mishap**

An OSHA representative performed a site investigation on March 21, 2006.

SGS formed a mishap investigation board on March 17, 2006. Written direction appointing a mishap investigation board president was signed by the president of SGS on March 20, 2006.

The NASA Type A Building M6-794 Roofing Fatality Mishap Investigation Board, hereafter referred to as the Board, convened on March 22, 2006 and began executing its responsibilities in accordance with NASA Procedural Requirement (NPR) 8621.1A, NASA Procedural Requirements for Mishap Reporting, Investigating, and Recordkeeping. The formal appointment letter was issued on March 24, 2006, and was signed by the KSC Director on March 24, 2006. The Board conducted its investigation independently of the actions taken by OSHA and SGS.

On March 24, 2006, the Board released the mishap site, and SGS directed another construction contractor (Sauer, Inc.) to cover the opening left on the northeast corner of the M6-794 roof because rain was expected and flight hardware was in the building. This opening was left on the roof by Oneida because all work had stopped subsequent to the mishap on March 17. On March 27, 2006, Oneida returned to the job site to complete all remaining work on the M6-794 roof, using adequate fall protection.

### 3. INVESTIGATION

#### 3.1 Approach

The purpose of the Board was to gather information; analyze the facts; identify the proximate causes, root causes, and contributing factors relating to the mishap; and recommend appropriate actions to prevent a similar mishap from occurring in the future.

The Board met with the leader of the Incident Response Team (IRT), visited the mishap site, identified and interviewed witnesses, and analyzed events and conditions to identify proximate and root causes of the mishap. Each element of the investigation is further described in the following subsections.

#### 3.2 Chronology of Mishap Investigation

On March 22, 2006, the IRT lead briefed the Board on the activities that occurred at the mishap site from the time the mishap occurred to appointment of the Board. Witness statements taken at the site were turned over and entered into the Board files.

The Board's first data collection effort was to visit the mishap site on March 22, 2006 (see Figures 1 through 5). SGS erected scaffolding to allow the Board access to view the roof. Photographs were taken of the roof, impact area, and general conditions of the building and surrounding area. In addition, the Board was aware of a witness who saw the mishap from an adjacent building. Photographs were taken from that witness's line of sight. Measurements were taken of the roof area, impact area, and the witness's distance from the roof. Physical evidence belonging to the deceased was secured.

The Board then identified an initial interview list. Interviews of workers involved, management, safety specialists, fall protection specialists, and trainers were scheduled and conducted. The list was continually updated based on data received from witness statements, documents collected, discussions with managers on suggested issues/areas of emphasis, development of a timeline, and development of the event and causal-factor tree. During the course of the investigation, institutional cultural safety issues, both within NASA and at the contractor level, were explored, expanding the interview list. The interview list remained open and was continually expanded throughout the investigation.

A timeline of the key events leading up to the mishap was initially constructed, identifying all of the events related to the mishap, along with dates and times that were known. The timeline of the mishap was further developed using data gathered in interviews and records of the emergency response personnel. The timeline remained a working document, continually updated as witness statements and documents were received.

Using an expanded event and causal-factor tree (developed with Relex Fault Tree Analysis software) to assess all possible events and causes, the Board began to identify proximate causes. A proximate cause is an event that occurred or condition that existed immediately before the mishap that directly resulted in the mishap occurrence, and if eliminated or modified, would have prevented the undesired outcome. The Board also consulted Modified Incident Analysis

Technique (IAT), Management Oversight Risk Tree (MORT), and Taproot logic to trigger questions that help link what happened with why it happened. The tree was pared down to the plausible events and causes that eventually led to the identification of the root causes, which are those events, conditions, or organizational factors that contributed to or created a proximate cause, and if eliminated or modified, would have prevented the mishap. Contributing factors, observations, and failed barriers were also noted. Recommendations were developed to specifically address each root cause, the implementation of which should help prevent this type of mishap from recurring.

### 3.3 Data Collection and Development

#### 3.3.1 Evidence, Interviews, and Documentation

Physical evidence included medical results (e.g., KSC/Cape Canaveral Air Force Station [CCAFS] EMS report and medical examiner's report), Computer-Aided Dispatch (CAD) Incident Sheet, and items collected from the deceased and the mishap site. Physical evidence belonging to the deceased (i.e., harness, lanyard, hammer, shoes, leather clip, hammer, bag with screws) was secured from the KSC Institutional Safety and Quality Branch. An evidence log was developed. All individuals, excluding those working on the Board, were required to sign the log prior to viewing the evidence.

The Board conducted formal (privileged) and informal interviews. For the formal interviews, the Board instituted a policy of having two or three Board members present during each interview and executed it throughout the investigation. With permission from each witness, the Board used a court reporter during the formal interviews. This process proved highly effective in that real-time transcripts were provided to the Board. Interviewers recognized the value of being able to listen to witness discussion for follow-up questioning without the distraction of having to take detailed notes. The informal interviews were conducted in the presence of either the entire Board or a partial Board, but without a court reporter. These included interviews with fall protection specialists, both civil service and contractor, to assist the Board on technical questions.

Records and documentation were gathered as part of the interview process. Some witnesses were asked to bring documents as part of the interview. Document requests were made of NASA officials, the prime contractor, and the subcontractor. All parties were responsive to requests. Other documents were gathered by Board members. The major area of emphasis on document gathering was safety requirements, procedures and practices of the prime contractor and subcontractor, Federal regulatory requirements, NASA requirements, and KSC requirements. Documentation was requested and received from all parties related to actual implementation of these safety requirements as they applied to the specific job. Included in the data gathering were procurement regulations and contractual documents to analyze safety flowdown requirements.

See Appendix A for a list of all reference documents; Appendix B for terms and definitions; Appendix C for abbreviations, acronyms, and symbols used in this report; Appendix D for OSHA's Form 301 completed for the Building M6-794 roofing fatality; Appendix E for the Interim Safety Alert; and Appendix F for the Event and Causal-Factor Tree (Relex).

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3.3.2 Timeline

The Board organized the events into a timeline, which is portrayed in Table 1.

Table 1. Mishap Timeline

Date	Time (EST)	Event
09/15/05		SGS awarded roofing contract to Oneida Construction, Inc.
09/15/05		Limited Notice to Proceed issued by SGS.
09/15/05		Pework conference held.
09/19/05		Oneida safety plan completed (fall protection included). Oneida superintendent training certifications included.
09/23/05		SGS Safety approved Oneida safety plan.
09/23/05		Full Notice to Proceed issued by SGS.
11/11/05		Materials delivered to job site.
11/14/05		Site work began (screw replacement).
12/05/05		Training certifications completed for Oneida Workers 1 and 2 (fall protection included).
12/12/05		Stop Work Letter issued by SGS because of roof leaks.
03/15/06		SGS subcontract administrator and Oneida agree at weekly status meeting that site work would resume on 03/17/06.
03/15/06		SGS construction monitor left voice message with SGS safety monitor stating that site work would resume on 03/17/06.
03/16/06	AM	Oneida presented materials from KSC Safety Standdown to its employees at regular weekly safety meeting.
03/17/06	0650	SGS construction monitor (not safety monitor) visited worksite—no workers onsite.
03/17/06	0700	SGS construction monitor departed job site.
03/17/06	0747	Oneida superintendent and Oneida Workers 1 and 2 arrived onsite but could not begin work because the aerial lift had not arrived.
03/17/06	0747	SGS construction monitor visited work site—Oneida superintendent and Workers 1 and 2 onsite waiting for aerial lift to begin work.
03/17/06	~ 0750	Oneida superintendent briefed SGS construction monitor on work to be done.
03/17/06	0800	SGS construction monitor left job site.
03/17/06		Oneida crew informally discussed work to be done.
03/17/06	~ 1015	Aerial lift arrived.
03/17/06		Crew replaced panels on northwest corner of roof, with Workers 1 and 2 working from the aerial lift while the superintendent worked from the roof.
03/17/06		Crew replaced panel on southeast corner, working from the roof.
03/17/06		Break for lunch (Oneida superintendent ate lunch separately; Oneida Workers 1 and 2 drove to lunch).
03/17/06	1310	SGS construction monitor stopped at job site to check progress.
03/17/06	1310	Crew returned to job site.
03/17/06	~1320	SGS construction monitor left job site.
03/17/06	~ 1320	Crew finished installing fasteners on the southeast corner of roof.
03/17/06		Crew walked to northeast corner of roof.
03/17/06		Superintendent loosened tongs on lightning protection wire clamps.
03/17/06		Crew predrilled holes in third (final) metal roofing panel.
03/17/06		Crew began installing the final metal roofing panel in the northeast corner of roof. Superintendent/safety monitor assisted by holding top end of roofing panel.



Date	Time (EST)	Event
03/17/06		Worker 1 lifted lower end of roofing panel and began moving toward leading edge of roof while rotating panel into position, with superintendent/safety monitor holding other end.
03/17/06	~ 1324	Logistics coordinator from Building M6-744 heard outside noise, went to investigate, and noticed roofers working on the M6-794 roof.
03/17/06	~ 1325	Worker 1 fell from roof while working on the northeast corner panel.
03/17/06	1325	SGS logistics coordinator called 911 from Building M6-744.
03/17/06	~ 1325	Oneida superintendent and Worker 2 left roof via aerial lift and ran to scene.
03/17/06		Oneida employee asked SGS logistics coordinator (witness) if he called 911, and witness confirmed 911 call was made.
03/17/06	1327	Fire/Rescue (F/R) and Emergency Medical Services (EMS) dispatched.
03/17/06	1328	Fire/Rescue first responder and EMS (seconds later) arrived on scene.
03/17/06	1329	Initial patient contact.
03/17/06	1329	F/R and EMS requested helicopter transport.
03/17/06	1329	F/R and EMS requested second F/R ladder truck and second ambulance.
03/17/06	1331	First Flight (Holmes Regional Medical Center helicopter medevac) not available; Air Care (ORMC medevac helicopter) called in.
03/17/06	~ 1335	Second ambulance arrived on scene.
03/17/06	~ 1340	Medical director from KSC Occupational Health Facility (OHF) arrived on scene.
03/17/06	1341	NASA Safety Office notified.
03/17/06	~ 1350	NASA safety specialist arrived on scene, took witness statements, and assumed responsibility as Incident Response Team (IRT) lead.
03/17/06	1356	Air Care medevac helicopter arrived on scene.
03/17/06	1403	Air Care patient contact.
03/17/06	1405	Patient transported to Air Care medevac helicopter.
03/17/06	1410	Air Care medevac helicopter departed to ORMC with patient.
03/17/06	~ 1428	Patient arrived at ORMC.
03/17/06	1606	Patient pronounced dead.
~ indicates approximate time.		

### 3.3.3 OSHA Regulations

OSHA 29 CFR 1926, Subpart M, was referenced for this investigation since the original contract and safety plan identified the job task as low-sloped roofing work. An OSHA investigation after the mishap identified this portion of the roofing work as steel erection, which is covered by 29 CFR 1926, Subpart R. Specific OSHA references and/or requirements text are used as they apply within the following analysis and findings.

## 3.4 Analysis

### 3.4.1 Proximate Causes

After reviewing the chain of events in the timeline, the Board developed a preliminary set of proximate causes, which included working close to the edge, loss of balance, and improper fall protection. This preliminary set evolved into the final proximate causes.

### 3.4.2 Events and Causal-Factors Analysis

An events and causal-factors (E&CF) tree was generated, with the preliminary proximate causes as the first line of development. Each branch of the tree was further developed to examine all reasonable or possible hypotheses for how the mishap could have occurred, and to systematically rule out as many alternatives as the evidence allowed. As the investigation progressed, items were added and discussed. This tree was called the expanded E&CF tree. (See subsection 3.4.4. for items not further developed.)

The factors that were determined to be likely contributors to the mishap and the supporting evidence were developed further in a second, condensed tree. The remaining blocks were cleaned up, reworded, and combined to show the actual events resulting in the mishap. Contributing factors, failed barriers, root causes, and observations were identified. The following subsections provide narrative relating to these events and causes and the Board's analysis of the chain of conditions and events that caused the mishap. This analysis is consistent with the branches of the condensed E&CF tree. Section 4 presents a summary of the findings with accompanying recommendations.

Starting with the mishap event "Fatality," the Board evaluated the final proximate causes and those events and conditions that led up to them. See Figure 6.

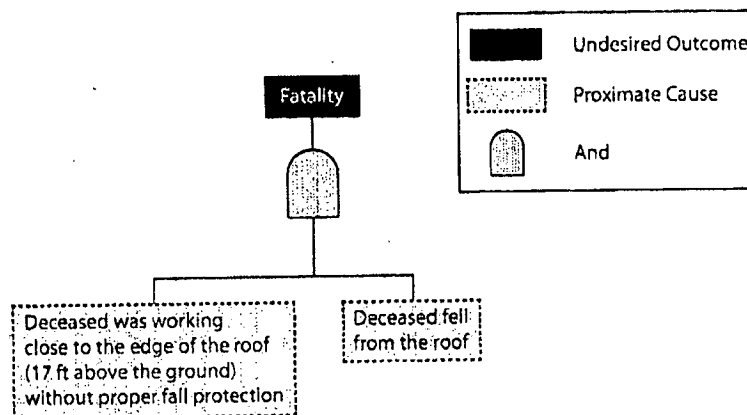


Figure 6. Proximate Causes of Fatality

#### 3.4.2.1 Proximate Cause 1: Deceased was working close to the edge of the roof (17 ft above the ground) without proper fall protection

SGS awarded Subcontract X04524-6 to Oneida Construction, Inc., on September 15, 2005. The scope of work defined in the Oneida contract consisted of removal and replacement of existing aluminum roofing panels at the four corners of Building M6-794. Each metal roofing panel was 3 ft wide by 16 ft long and weighed approximately 46 pounds. Removal and replacement also included installing new flashing as required and replacing or reinstalling the existing gutter

systems and lightning protection terminals as necessary. Additional scope included removal and replacement of all existing roof panel fasteners (screws).

The northeast corner (mishap location) could not be reached by the aerial lift because a ground air-conditioning unit interfered with placement of the lift to access the work area. Therefore, the planned work method was for two workers to carry the panel to the roof work location, with one worker (the deceased) at the downslope end of the panel and the other worker at the upslope end. Fall protection for the two workers handling the panel was to be provided by a third crew member acting as the superintendent/safety monitor. This method of fall protection was in the Oneida Safety and Health Plan and was approved by SGS Safety, Health, and Training.

During the actual work, the superintendent/safety monitor and the deceased worker maneuvered the panel into the required position, which placed the deceased close to the edge of the roof, with his back to the edge. The superintendent, who should have provided the safety monitoring, did not warn the deceased that he was close to the edge (approximately 6 to 12 inches). No other additional fall protection (physical tie-offs, guardrails, safety nets, etc.) was provided. Therefore, the Board determined a proximate cause of the mishap to be that the deceased was working close to the edge of the roof (17 ft above the ground) without proper fall protection.

The intermediate causes of the deceased's working close to the edge of the roof without proper fall protection were identified and analyzed and are presented in Figure 7 and the following subsections.

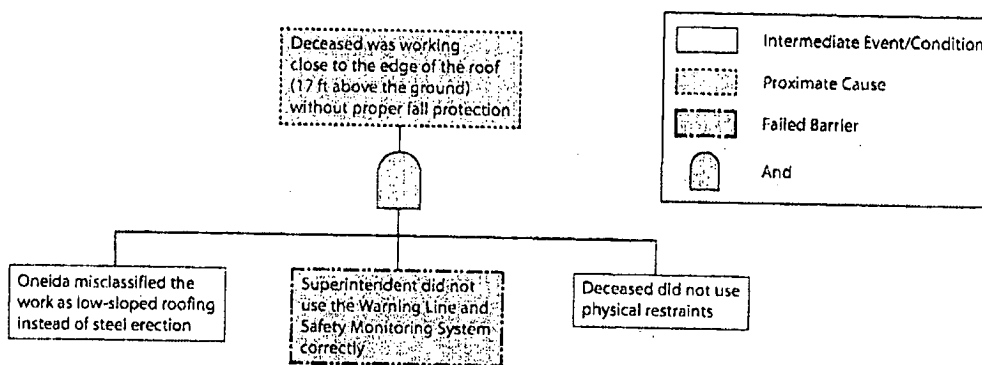


Figure 7. Events Leading to the Deceased's Working Close to the Edge of the Roof Without Proper Fall Protection

#### 3.4.2.1.1 Oneida misclassified the work as low-sloped roofing instead of steel erection

From inception, both SGS and Oneida considered this project to be and managed it as if it were a low-sloped roofing project. Accordingly, SGS permitted and Oneida used a Warning Line and Safety Monitoring System as the means of fall protection, when the use of a body harness and lanyard was not possible because of anchorage points not being available. This is in compliance with the OSHA Low-slope Roofing requirements of 29 CFR 1926.501(b)(10), which states:

Comment [m2]: Debby, This capitalization is the way it is used in OSHA.

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*"Roofing work on Low-slope roofs. Except as otherwise provided in paragraph (b) of this section, each employee engaged in roofing activities on low-slope roofs, with unprotected sides and edges 6 feet (1.8 m) or more above lower levels shall be protected from falling by guardrail systems, safety net systems, personal fall arrest systems, or a combination of warning line system and guardrail system, warning line system and safety net system, or warning line system and personal fall arrest system, or warning line system and safety monitoring system. Or, on roofs 50-feet (15.25 m) or less in width (see Appendix A to subpart M of this part), the use of a safety monitoring system alone [i.e. without the warning line system] is permitted."*

After the mishap, an OSHA investigation determined this particular work to be steel erection according to 29 CFR 1926, Subpart R. Steel erection is defined as the construction, alteration, or repair of steel buildings, bridges, and other structures, including the installation of metal decking and all planking used during the process of erection. Specifically, a letter of Standard Interpretation dated November 8, 2002, stated that replacement of metal roof panels is steel erection, covered by 29 CFR 1926.750(b)(1). The same letter also specifies that control decking zones (CDZs), which do not require fall protection if under 30 ft in height, may only be used for the *initial installation* of metal decking. Because this work was (1) a metal decking repair, (2) not an initial installation, (3) not being performed in a CDZ, and (4) over 15 ft in height, OSHA's interpretation was that the workers were required to be "protected by guardrail systems, safety net systems, personal fall arrest systems, positioning device systems or fall restraint systems" (29 CFR 1926.760(a)(1)).

Based upon the OSHA letter of Standard Interpretation and the OSHA postmishap investigation, the Board determined that Oneida misclassified the work as low-sloped roofing instead of steel erection. **Oneida was unaware of the OSHA interpretation to classify the work as steel erection (Root Cause 1).** SGS did not inform Oneida that the work was steel erection because SGS also misclassified the work as low-sloped roofing instead of steel erection.

**SGS was unaware of the OSHA interpretation to classify the work as steel erection (Root Cause 2)** until OSHA conducted its postmishap investigation. Adherence to and implementation of the more stringent fall protection requirements for steel erection described in 29 CFR 1926, Subpart R, may have prevented the mishap. See Figure 8.

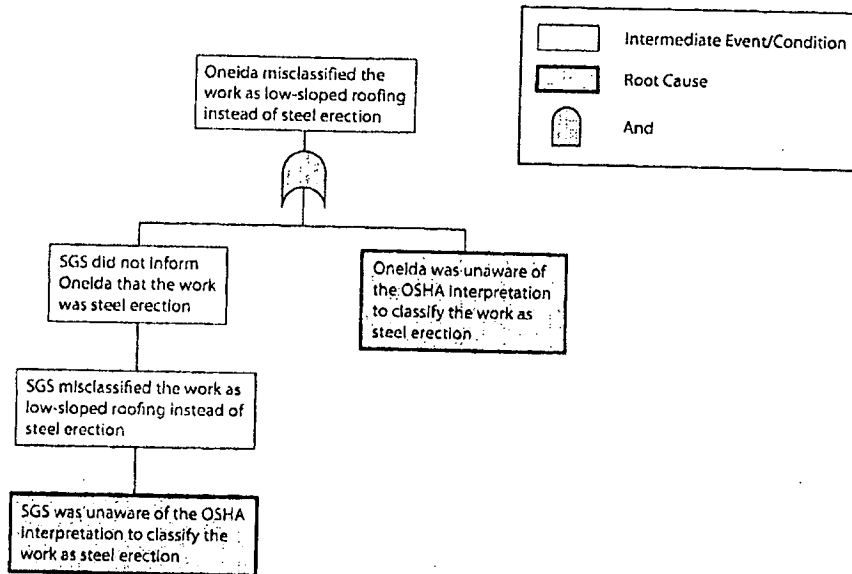
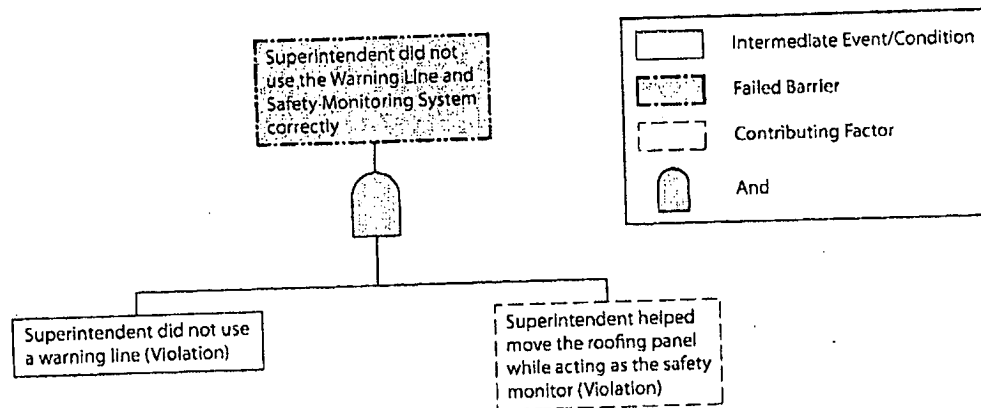


Figure 8. Root Causes of Oneida Misclassifying the Work as Low-Sloped Roofing Instead of Steel Erection

3.4.2.1.2 Superintendent did not use the Warning Line and Safety Monitoring System correctly (Failed Barrier)

The Warning Line and Safety Monitoring System, which is permitted by OSHA 29 CFR 1926.501(b)(10) for work on low-sloped roofs, was not used properly by the Oneida superintendent. Two OSHA violations were that the superintendent (1) did not use a warning line and (2) helped the Oneida workers carry the roofing panel while acting as the safety monitor (Figure 9).



**Figure 9. Violations Contributing to Superintendent's Failure To Use the Warning Line and Safety Monitoring System Correctly**

#### 3.4.2.1.2.1 Superintendent did not use a warning line (Violation)

Omission of a warning line was a violation of the OSHA requirement because in lieu of other fall protection systems a Warning Line and Safety Monitoring System is allowed for work on low-sloped roofs (slopes less than 4:12 vertical:horizontal, rise to run). The roof of Building M6-794 has a slope of 2:12, which permitted the use of a safety monitor with a warning line system. On roofs that are less than 50 ft wide, a warning line is not required. However, the roof of Building M6-794 is approximately 120 ft wide, therefore requiring that a warning line be used in conjunction with the safety monitor.

The root causes of and observations regarding the warning line violation are illustrated in Figure 10 and discussed below.

- Superintendent experienced no consequences from previous violations identified by SGS Safety (SGS subcontract number XO5539).
- Oneida did not ensure its superintendent's compliance with the OSHA requirement for fall protection (Root Cause 3).

Oneida considered this work to be low-slope roofing and was using a Warning Line and Safety Monitoring System as fall protection. The Board noted that the superintendent had been written up by SGS Safety for warning line and safety monitor violations on three separate occasions prior to this mishap. However, the noncompliances were corrected on the spot and no further retraining, corrective action, or disciplinary action was taken by Oneida toward the superintendent or by SGS toward Oneida. The Board determined that because the noncompliances could have had fatal consequences and were committed by the same individual over a 6-day period, the noncompliances should have been an indicator to SGS and Oneida management of the superintendent's lack of implementation of this

OSHA requirement. These noncompliances did not indicate a lack of knowledge of the warning line because the superintendent took corrective action after each notice of noncompliance by SGS Safety.

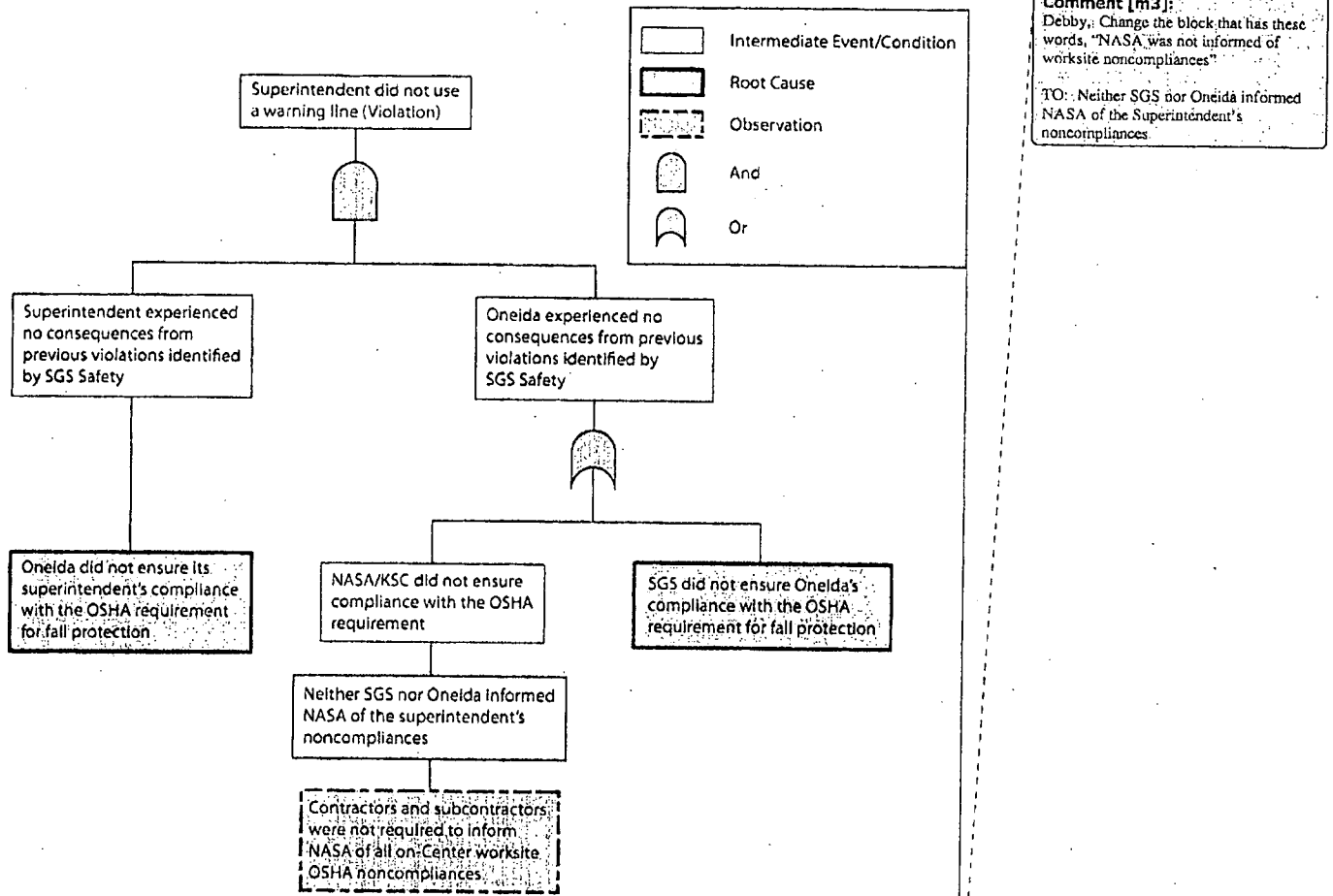


Figure 10. Root Causes of and Observations Regarding Warning Line Violation

- c. Oneida experienced no consequences from previous violations identified by SGS Safety.

SGS submitted seven Oneida subcontract records to the Board, comprising 59 inspection records (33 were active sites and 26 showed no activity). Of the 33 records for active sites, 7 identified safety violations, 3 of which related to fall protection. Despite these nonconformances SGS took no contractual actions toward Oneida.

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- d. NASA/KSC did not ensure compliance with the OSHA requirement.
  - (1) Neither SGS nor Oneida informed NASA of the superintendent's noncompliances.
  - (2) Contractors and subcontractors were not required to inform NASA of all on-Center worksite OSHA non-compliances (Observation 6), and does not have a policy requiring contractors and subcontractors to report such noncompliances.
- e. SGS did not ensure Oneida's compliance with the OSHA requirement for fall protection (Root Cause 4).

SGS allowed Oneida workers to perform roofing work without proper fall protection. The Oneida superintendent failed to use a warning line, in violation of OSHA regulations for low-sloped roofing work. He also helped move a roofing panel while acting as safety monitor, also an OSHA violation. Although SGS had previously written up the superintendent for warning line and safety monitor noncompliances, no contractual action was taken by SGS toward Oneida. Also, the Board had no evidence to suggest these noncompliances were ever presented to the Oneida owner/president.

**3.4.2.1.2.2 Superintendent helped move the roofing panel while acting as the safety monitor (Violation) (Contributing Factor 1)**

Factors contributing to and observations regarding the safety monitor violation are illustrated in Figure 11 and discussed below.



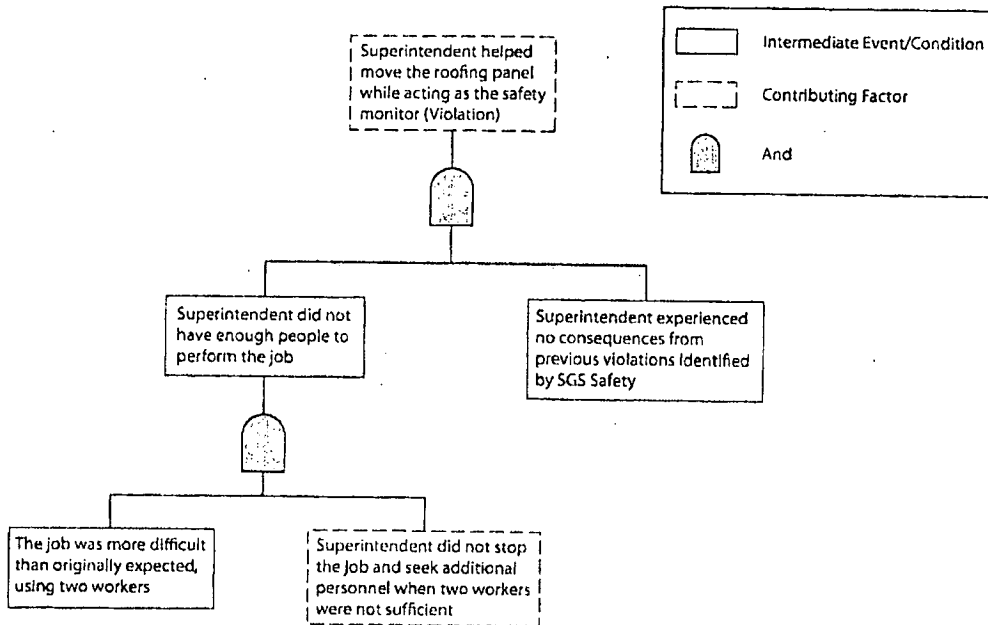


Figure 11. Factors Contributing to and Observation Regarding the Safety Monitor Violation

- a. OSHA 29 CFR 1926.502(h) states that the employer shall designate a competent person to monitor the safety of other employees, and that the employer shall ensure that the safety monitor complies with the following requirements: (1) be competent to recognize fall hazards; (2) warn the employee when it appears that the employee is unaware of a fall hazard or is acting in an unsafe manner; (3) be on the same walking/working surface and within visual sighting distance of the employee being monitored; (4) be close enough to communicate orally with the employee; and (5) *not have other responsibilities which could take the monitor's attention from the monitoring function* (emphasis added).

OSHA 29 CFR 1926.32(f) defines "competent person" as one who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

The Board concluded that the superintendent/safety monitor performed his duties improperly based on his location on the roof during his monitoring responsibilities, his failure to identify tripping hazards, and his act of physically assisting the workers with the roofing panel.

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- b. Superintendent did not have enough people to perform the job.

The job was more difficult than originally expected, using two workers. While replacing two other panels earlier in the morning on the same roof, the superintendent recognized a hazard to the fingers of the person lifting the leading edge of the adjacent sheet metal. As the workers slid the new sheet underneath the adjacent sheet while holding the edge up, their fingers were being pinched. By having a third person hold up the edge of the adjacent sheet, the pinch point hazard was eliminated. Instead of keeping himself free of other functions to act as safety monitor, the superintendent assisted the other workers with their task rather than seeking additional personnel. **Superintendent did not stop the job and seek additional personnel when two workers were not sufficient (Contributing Factor 2).**

- c. Superintendent experienced no consequences from previous violations identified by SGS Safety (SGS subcontract number XO5539).

The Board noted that the superintendent had been written up by SGS Safety for failure to use a warning line on three separate occasions prior to this mishap. However, the noncompliances were corrected on the spot and no further retraining, corrective action, or disciplinary action was taken by Oneida toward the superintendent or by SGS toward Oneida. The Board determined that because the noncompliances could have had fatal consequences and were committed by the same individual over a 6-day period, the noncompliances should have been an indicator to SGS and Oneida management of the superintendent's lack of implementation of this OSHA requirement. These noncompliances did not indicate a lack of knowledge of the warning line because the superintendent took corrective action after each notice of noncompliance by SGS Safety.

3.4.2.1.3 Deceased did not use physical restraints

Events leading to the failure of the deceased to use physical restraints are illustrated in Figure 12 and discussed below.

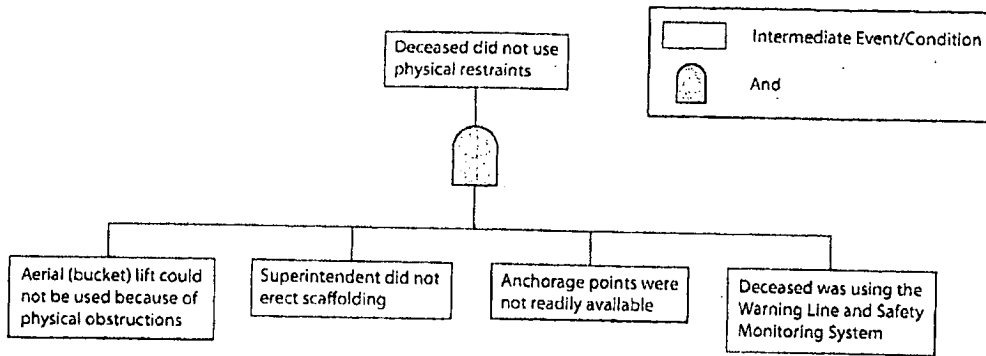


Figure 12. Events Leading to the Failure of the Deceased To Use Physical Restraints

- a. Aerial (bucket) lift could not be used because of physical obstructions.

The superintendent determined that an aerial lift could not be used to access the area of the roof where the mishap occurred. This was due to the presence of an air-conditioning unit on the loading dock below, and steam lines (heat pipes) and railroad tracks below that level. This prompted the crew to work from the roof.

- b. Superintendent did not erect scaffolding (Figure 13).

Scaffolding was not used to access the area of the roof where the mishap occurred because of the limited space available on the loading dock directly below. The available space was 7 ft 8 in wide by 12 ft deep, with width being the limiting dimension. This limited width was the result of a large air-conditioning unit being located 7 ft 8 in away from the east end of the loading dock.

After the mishap, scaffolding was installed in the available 7-ft 8-in-wide area to provide the Board a view of the roof. This scaffolding would not have allowed the workers full access to all areas of the leading edge where the work was being performed. Therefore, additional fall protection would still have been needed, besides scaffolding, to meet the fall protection requirements.

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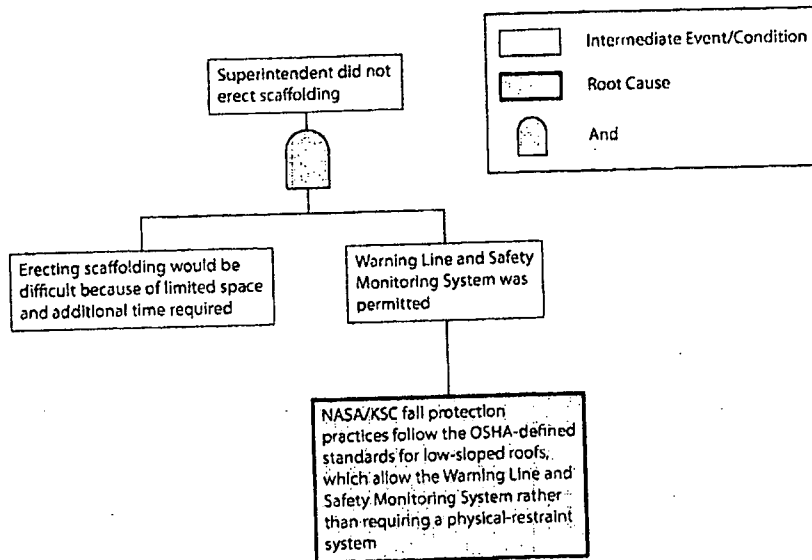


Figure 13. Events Leading to the Superintendent's Decision Not To Erect Scaffolding

For work on low-sloped roofs (slopes less than 4:12 vertical:horizontal, rise to run), an employer is permitted by OSHA 29 CFR 1926.501(b)(10) to use a Warning Line and Safety Monitoring System in lieu of other fall protection systems. The roof of Building M6-794 has a slope of 2:12, which permitted the use of a Warning Line and Safety Monitoring System. On roofs that are less than 50 ft wide, a warning line is not required. However, the roof of Building M6-794 is approximately 120 ft wide, therefore requiring that a warning line be used in conjunction with the safety monitor.

The OSHA standard allowing for a safety monitor with a warning line system for the type of roof involved in the mishap is a minimum standard. **NASA/KSC fall protection practices follow the OSHA-defined standards for low-sloped roofs, which allow the Warning Line and Safety Monitoring System rather than requiring a physical-restraint system (Root Cause 5).** NASA/KSC management has the right to implement a more conservative fall protection policy, requiring a physical-restraint system. Had a physical restraint been used, there would not have been a fatality.

- c. Anchorage points were not readily available (Figure 14).

Neither permanent nor temporary anchorage points were available or made available on Building M6-794 at the time of the mishap. The Board determined that permanent anchorage points were not part of the original 1964 facility design. **Permanent anchors were not added later, and KSC policy did not require their installation (Observation 8).**

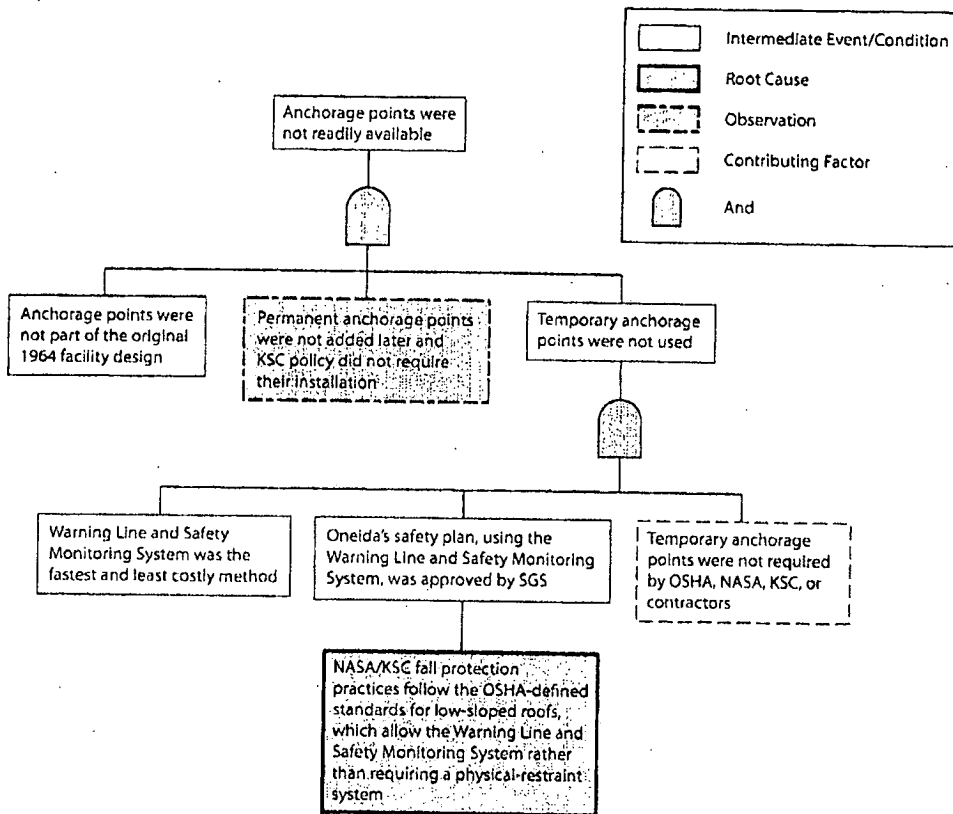


Figure 14. Events Leading to the Unavailability of Anchorage Points

Temporary anchorage points were not used by the Oneida roofing crew for several reasons. First, the Warning Line and Safety Monitoring System (permitted by OSHA for low-sloped roofing work) was the fastest and least costly method to perform this job. Temporary anchorage points were not required by OSHA, NASA, KSC, or contractors. There is no evidence that temporary anchorage points, which could have been provided by Oneida, were ever considered prior to the roofing job commencing. In fact, the Oneida safety plan, which permitted the use of the Warning Line and Safety Monitoring System, was properly submitted and approved by SGS Safety, Health, and Training in accordance with SGS OSH-P-0215, Construction and Service Subcontractor Safety Program. The plan also complied with OSHA, NASA, KSC, and contractor safety requirements for low-sloped roofing work. The use of alternative methods, such as temporary tie-offs or scaffolding, would have required additional time and cost to plan and set up. It should be noted that after the mishap, a temporary fall protection system (life lines) was used to allow the roofing job to be completed.

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The OSHA standard allowing for a Warning Line and Safety Monitoring System for the type of roof involved in the mishap is a minimum standard. NASA/KSC fall protection practices follow the OSHA-defined standards for low-sloped roofs, which allow the Warning Line and Safety Monitoring System rather than requiring a physical-restraint system (Root Cause 5). NASA/KSC management has the right to implement a more conservative fall protection policy, requiring a physical-restraint system. Had a physical restraint been used, there would not have been a fatality.

- d. Deceased was using a Warning Line and Safety Monitoring System (Figure 15).

The scope of work consisted, in part, of removal and replacement of existing aluminum roofing panels at the four corners of Building M6-794. From inception, Oneida considered this project to be and managed this project as if it were a low-sloped roofing project. Oneida misclassified the work as low-sloped roofing instead of steel erection. Accordingly, Oneida used the Warning Line and Safety Monitoring System as the primary means of fall protection when the use of a body harness and lanyard was not possible because of anchorage points being unavailable.

On the morning of March 17, 2006, the day of the mishap, the deceased was using the Warning Line and Safety Monitoring System as a means of fall protection in performance of this work. This system complied with OSHA requirements for work being performed on a low-sloped roof. OSHA 29 CFR 1926, Construction Industry Regulations, permits the use of a Warning Line and Safety Monitoring System. The specific reference is as follows:

OSHA 29 CFR 1926.501(b)(10):

*"Roofing work on Low-slope roofs. Except as otherwise provided in paragraph (b) of this section, each employee engaged in roofing activities on low-slope roofs, with unprotected sides and edges 6 feet (1.8 m) or more above lower levels shall be protected from falling by guardrail systems, safety net systems, personal fall arrest systems, or a combination of warning line system and guardrail system, warning line system and safety net system, or warning line system and personal fall arrest system, or warning line system and safety monitoring system. Or, on roofs 50-feet (15.25 m) or less in width (see Appendix A to subpart M of this part), the use of a safety monitoring system alone [i.e. without the warning line system] is permitted."*

The Building M6-794 roof met the requirement for a low-sloped roof (2:12 horizontal:vertical slope) but was wider than 50 ft (approximately 120 ft). This regulation permitted the use of a warning line system combined with a safety monitoring system for the Building M6-794 roof, but a safety monitor alone was not sufficient because of the width of the roof.

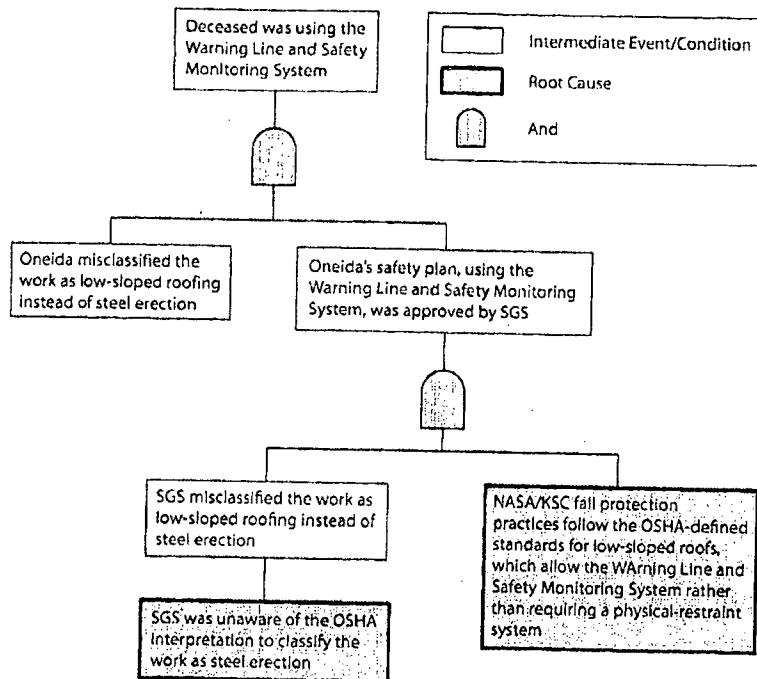


Figure 15. Events Leading to Use of the Warning Line and Safety Monitoring System

SGS's Request for Proposal (RFP) Number X04524, "High Wind Resistance Roof Repairs, Building M6-794, Supply Warehouse #1, KSC," was issued on July 25, 2005. The RFP contained an attachment titled "Safety Information and Requirements," which summarizes safety information, requirements, and regulations that subcontractors must follow whenever conducting work for SGS. Included in this attachment is the following requirement:

*Paragraph 33.0, SAFETY PLANS*

- 33.1 *A project specific safety and health plan shall be written to the safety and health aspects of the job. Corporate safety and health plans will not suffice. Applicable portions of this attachment shall be used to develop the required safety and health plan. Review and acceptance of the safety plan by SGS SH&T shall occur prior to commencement of work. Any specialized safety requirements (Confined Space, Management of Traffic, Radiation Safety Control Zones, etc.) shall be included in the Safety Plan either in the body of the plan or an attachment.*
- 33.2 *The site safety plan shall apply to all employees working on the site, whether they are Subcontractor or sub-tier employees. The Subcontractor*

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*shall be responsible for ensuring all employees follow the prescribed safety plan.*

- 33.3 *As a minimum, safety plans shall address all the items checked on the Safety Plan Requirements Checklist (Table 2). Additional items shall be addressed as necessary based on the specifics of the project. The Safety Specialists shall complete the Safety Plan Requirements Checklist and provide it to Subcontractors at the Pre-Bid meeting.*
- 33.4 *When work is accomplished on CCAFS or PAFB, the portion of the Subcontractors safety plan that deal with public safety shall be sent to the Air Force to satisfy their "Accident Prevention Plan" requirements. SGS Subcontractors may provide a sample.*

Oneida's project-specific safety plan permitting the Warning Line and Safety Monitoring System as a means of fall protection was submitted to SGS on September 19, 2005, and approved on September 23, 2005. The applicable language from the safety plan reads as follows:

*"Fall protection is used as a means of preventing workers for experiencing accidental falls from elevations. Fall protection shall be used by all Contractor employees working in an area where a fall hazard exists. All fall protection systems shall comply with OSHA 1926 Subpart M.*

*Contractor employees shall use OSHA and ANSI approved body harnesses and lanyards. Lanyards shall be attached above waste level to approved attachment points capable of withstanding 5000 pounds. Lanyards shall not be attached together. Where body harness and lanyards are not feasible, guardrail systems or positioning device systems shall be used.*

*Contractor employees engaged in low sloped roof activities may use a combination of the warning line system and safety monitoring system when the use of body harness and lanyard is not possible."*

After the mishap, an OSHA investigation determined this particular work to be steel erection in accordance with 29 CFR 1926, Subpart R. Specifically, a letter of Standard Interpretation dated November 8, 2002, stated that replacement of metal roof panels is steel erection, covered by 29 CFR 1926.750(b)(1). SGS was unaware of the OSHA interpretation to classify the work as steel erection (Root Cause 2). SGS's unawareness of the OSHA interpretation prevented them from correctly classifying the job as one that required more stringent fall protection, which in turn might have prevented the fall.

In addition, NASA/KSC fall protection practices follow the OSHA-defined standards for low-sloped roofs, which allow the Warning Line and Safety Monitoring System rather than requiring a physical-restraint system (Root Cause 5).



### 3.4.2.2 Proximate Cause 2: Deceased fell from the roof

#### 3.4.2.2.1 Deceased lost his balance

Events and conditions that may have contributed to the deceased's loss of balance are illustrated in Figure 16 and discussed below.

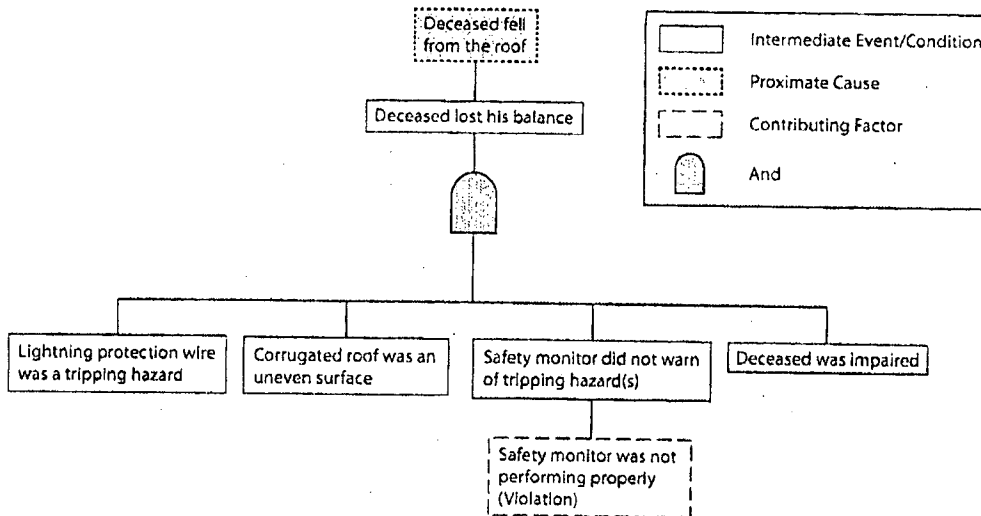


Figure 16. Events Leading to the Deceased's Loss of Balance

The Board determined that the deceased either tripped or stumbled prior to falling off the roof rather than simply backing off the roof. The two most likely tripping hazards were the lightning protection wire that was located approximately 6 inches from the edge of the roof and the uneven working surface caused by the corrugated roof. The Board also determined that there was no oral warning provided by the superintendent/safety monitor to possibly allow the deceased to avoid the tripping hazard.

#### a. Lightning protection wire was a tripping hazard.

Many buildings on KSC have lightning protection wire along the edge of the roof. The wire is generally taut. The wire on Building M6-794 was located approximately 6 inches from the edge of the roof. This caused difficulties because the panels had to be slid under the wire. The wire had only a few inches of play, which restricted movement of the panel and required a repetitive process of moving the wire a few inches, moving the panel a few inches, and repeating the process until the panel was in place. To make the installation of the last panel easier, the Oneida workers removed one or two tongs (anchoring mechanism for the wire). This provided slack in the wire and allowed for easier placement or sliding of the panel into position. It is not known if loosening the wire made it

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more of a tripping hazard. Evidence collected suggests the deceased, while losing his balance, got his right heel caught in the wire. This may have prevented him from stepping back with his right foot to regain his balance. It remains unclear if the wire caused the deceased to trip or lose his balance, or if it prevented him from regaining his balance. However, one of these three events occurred. Therefore, the lightning protection wire may have caused the deceased to lose his balance.

**b. Corrugated roof was an uneven surface.**

The working surface of the roof consisted of corrugated metal panels with raised ribs (1.5 inches high by 2 inches wide), spaced 12 inches apart on center. The valley or low spot of the corrugated panel is approximately 8 inches wide. There is not sufficient evidence to determine if the deceased's foot hit the corrugated surface at an awkward angle causing him to roll his ankle. The possible rolling of his ankle may have resulted in him initially losing his balance prior to his right foot getting caught in the lightning protection wire.

**c. Safety monitor did not warn of tripping hazard(s).**

One function of the safety monitor is to alert workers when they are coming close to the roof's edge. The superintendent/safety monitor did not identify the hazards prior to beginning work or signal to the deceased when he was precariously close to the lightning protection wire and the roof edge. Also, the superintendent helped move the roofing panel while acting as the safety monitor. See subsection 3.4.2.1.2.2.

**d. Deceased was impaired.**

Physical impairment of the deceased by drugs or alcohol could have increased the likelihood of his tripping, stumbling, or losing his balance; or upon tripping, stumbling, or losing his balance, being less able to regain his balance. The medical examiner's report concerning the deceased indicated that he was under the influence of alcohol and tested positive for the presence of tetrahydrocannabinol (THC), a marijuana metabolite. This was based on toxicological screening of antemortem blood (blood drawn before death) that was drawn at 1455 on March 17, 2006, about 90 minutes after the mishap and about 70 minutes before the deceased's death.

The blood alcohol content (BAC) of the deceased was .023 percent, as identified in the report of the Office of the Medical Examiner, District 9, State of Florida, using the antemortem blood sample, was .023 percent. Since the time the blood was drawn was about 90 minutes after the mishap, the deceased's BAC at the time of the mishap would have been higher. Generally, BAC decreases by .012 to .020 percent per hour, based on the individual's alcohol metabolism rate. Assuming the minimum rate of alcohol metabolism, the deceased's BAC could have been about .041 percent (or higher) at the time of the mishap. This is

consistent with two to three drinks with lunch that day or heavy drinking the night before. Outward signs of the effects of alcohol begin at about .03 percent BAC and include euphoria; talkativeness; increased self-confidence; decreased inhibitions; diminution of attention, judgment, and control; beginning of sensory-motor impairment; and loss of efficiency in finer performance tests. At approximately .04 percent BAC, the deceased could have had some performance decrement that affected his motor coordination and judgment, increasing the likelihood of his tripping, stumbling, or losing his balance, or decreasing his ability to right himself after a trip or stumble. As a point of comparison, the Florida Driving Standard for driving under the influence is 0.08 percent BAC.

The marijuana metabolites reported by the Office of the Medical Examiner, District 9, State of Florida, included delta-9 THC, which is the principal neuroactive ingredient (none detected), and delta-9 carboxy THC, an inactive ingredient (11 nanograms per milliliter). Since the active metabolite, delta-9 THC, was negative, it had been at least 2 hours since the use of marijuana (sometime before 1255). The presence of the inactive metabolite, delta-9 carboxy THC, indicates the deceased (1) smoked a single marijuana cigarette less than 4 hours before the blood was drawn (sometime after 1055), (2) smoked heavily the night before, or (3) both. There is disagreement in the literature as to whether marijuana use affects coordination and locomotion. It is unlikely that the use of a single marijuana cigarette by itself would have had a significant effect on the motor coordination of the deceased. However, even a small decrement in coordination or locomotion, combined with the effects of alcohol use, could have resulted in performance decrement greater than either the alcohol or marijuana use alone. As a result of these two factors, the deceased could have had some performance decrement that affected his motor coordination, increasing the likelihood of his tripping, stumbling, or losing his balance, or decreasing his ability to right himself after a trip or stumble.

This condition of impairment by drugs and alcohol may have contributed to the mishap, and therefore, the Board determined this to be a contributing factor in this mishap. **While not legally intoxicated under Florida's Driving Standard, the deceased was under the influence of alcohol and tested positive for marijuana (Contributing Factor 4).**

### 3.4.3 Additional Findings

#### 3.4.3.1 Contractor findings

##### 3.4.3.1.1 Inadequate coordination within SGS resulted in Oneida working without the knowledge of SGS Safety (Observation 7)

At a weekly status meeting, held on March 15, 2006, the SGS subcontract administrator and Oneida agreed that site work would resume on March 17, 2006 (after several weeks of inactivity). The SGS construction monitor was also notified on March 16 that the subcontractor would resume work on March 17, and he subsequently called the SGS Safety representative.

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(responsible for monitoring the subcontractor's performance) and left a voice message. However, the Safety representative did not listen to this voice message until after the mishap occurred. Therefore, Oneida resumed site work without the knowledge of SGS Safety.

**3.4.3.1.2 Oneida did not maintain a current list of employees who were working on the job site (Observation 1)**

As required by Subcontract X04524-6, Oneida submitted a safety plan, which listed employees they planned to have working on the job site. This plan also listed training certifications for each employee and was approved by SGS on September 23, 2005. Oneida was required to maintain this list, making updates as new employees came onto the job site, and keep a current copy on the job site. However, Oneida did not have a current employee list onsite on the day of the mishap (March 17, 2006).

**3.4.3.1.3 Oneida did not conduct, or did not document, all weekly safety meetings (Observation 2)**

Oneida was required to conduct and document weekly safety meetings. However, it is unclear whether they conducted all of these weekly meetings (during the time that there was site activity) because documentation was not available for all meetings.

**3.4.3.2 Drug and alcohol testing was not performed on Oneida workers involved in the mishap (Observation 10)**

The requirement for postmishap testing for drugs and alcohol was ambiguous.

There are five references to drug/alcohol testing in NPR 8621.1A, NASA Procedural Requirements for Mishap Reporting, Investigating, and Recordkeeping. Subsection 3.8, Initiate Drug Testing, states "If the mishap results in a fatality or personal injury requiring immediate hospitalization, or in damage estimated to be in excess of \$10,000 to government or private property, the supervisor shall initiate post-accident/unsafe practice testing per NPR 3792.1A, NASA Plan for a Drug-Free Workplace." Then under responsibilities, "1.4.18 f. The IRT shall: Advise the supervisor if drug testing should be requested."; "1.4.20 g. The Center Safety Office shall: Advise the supervisor that drug testing should be initiated."; and "1.4.22 c. Supervisors shall: Initiate drug testing after a mishap if the mishap results in a fatality, or personal injury requiring immediate hospitalization, or in damage estimated to be in excess of \$10,000 to government or private property." Finally in Figure 2, Mishap Organizational Responsibilities Matrix, it notes that the supervisor has the primary responsibility to initiate drug testing, while the IRT and the Center Safety Office have a support responsibility. Since this "mishap result[ed] in a ... personal injury requiring immediate hospitalization, the supervisor" should have "initiate[d] post-accident/unsafe practice testing per NPR 3792.1A, NASA Plan for a Drug-Free Workplace." Further, the IRT and the Center Safety Office should have advised the supervisor that drug testing should be initiated.

NPR 3792.1A, NASA Plan for a Drug-Free Workplace, states in subsection 1.2.2.7, "E.O. 12564 mandated that this Plan cover only Federal civil service employees," so this document was not applicable in this mishap. However, NPR 3792.1A further states "on March 28, 1996, NASA

implemented a requirement for NASA contractors to institute and maintain a program for achieving a drug-free workforce by providing for pre-employment, reasonable suspicion, random, postaccident, and followup testing of contractor employees responsible for safety-sensitive, security, or national security functions as required by the Civil Space Employee Testing Act of 1991. These requirements may be found at 48 CFR 1852.223." So this CFR is the applicable document for contractors (if the particular clause for development of a drug- and alcohol-free workplace is in their contract), not NPR 3792.1A. Therefore, there is no requirement in NPR 8621.1A for initiating drug testing in mishaps involving contractors.

48 CFR 1852.223-74(b)(1) states "The Contractor shall institute and maintain a program for achieving a drug- and alcohol-free workforce. As a minimum, the program shall provide for preemployment, reasonable suspicion, random, post-accident, and periodic recurring (follow-up) testing of contractor employees in sensitive positions for use, in violation of applicable law or Federal regulation, of alcohol or a controlled substance." This CFR clause is in Oneida's contract, so there is a requirement for the contractor to have a drug- and alcohol-free workforce. However, there was no requirement for the contractor's plan to include anyone except those in "sensitive positions." It states in 48 CFR 1823.570-1, Definitions, "Employee in a sensitive position means a contractor or subcontractor employee who has been granted access to classified information; a contractor or subcontractor employee in other positions that the contractor or subcontractor determines could reasonably be expected to affect safety, security, National security, or functions other than the foregoing requiring a high degree of trust and confidence; and includes any employee performing in a position designated 'mission critical' pursuant to the clause at 1852.246-70. The term also includes any applicant who is interviewed for a position described in this paragraph." Sensitive employee, as defined, would not have included the deceased or either of the other two Oneida workers on the roof. Therefore, there was no requirement for these individuals to be included in the company's drug- and alcohol-free workforce program.

The CFR requirement, however, is a minimum required program. Oneida's Drug-Free Workplace Policy applies to all employees. It notes that testing will be performed in accordance with Florida Statute §440.101 and §440.102 and will include job applicant, reasonable suspicion, routine fitness for duty, and follow-up drug testing; and it allows testing for amphetamines, cannabinoids, cocaine, phencyclidine, methaqualone, opiates, barbiturates, benzodiazepines, methadone, propoxyphene, codeine, heroin, hydromorphone, LSD, morphine, and alcohol. These Florida Statutes note that the individual must have been given notice of the plan and what is included in the plan. All three of the Oneida employees involved in the mishap (including the deceased) signed Certificates of Acknowledgment that they had "received and read this Company's Drug-Free Workplace Program and Policy Regarding Substance Abuse" and that the program was explained to them. The Statutes further state that reasonable suspicion testing includes "information that an employee has caused, contributed to, or been involved in an accident while at work," which was the case in this mishap.

Therefore, the only requirement to initiate postmishap drug testing was with the company (Oneida) itself in accordance with its own policy. But there is no procedure within Oneida's policy to determine who will initiate the testing or how it will be done. Further, while there is a requirement in 48 CFR 1852.223-74 that any individual who tested positive on the program be

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suspended from working in a sensitive position for NASA until rehabilitation has been successfully completed, there is no obligation for the company (in this case, Oneida) to report those results to either SGS (the prime contractor) or NASA. While there was a requirement on Oneida's part, according to its Drug-Free Workplace Program, to perform postmishap drug and alcohol testing on the employees involved in the mishap, this was not done.

**3.4.3.3 Other than OSHA minimum standards, no single, standardized fall protection policy exists across all NASA Centers or operating locations (Observation 9)**

Two questions were asked of Safety and Mission Assurance directors at all NASA Centers, plus Michoud Assembly Facility (MAF) and White Sands Test Facility (WSTF):

**Question 1:** *Describe your Center's policy with respect to work that is being conducted on a "low-sloped roof" and the use of a monitoring system versus fall protection systems.*

**Responses:** Centers' policies regarding use of the safety monitoring system versus positive fall protection fell into two categories:

- Warning Line and Safety Monitoring System Allowed: Six Centers (GSFC, GRC, ARC, KSC, JSC, and MSFC) and WSTF permit use of the Warning Line and Safety Monitoring System, which is the minimum OSHA requirement in 29 CFR 1926.501(b)(10).
- Warning Line and Safety Monitoring System Not Allowed: Four Centers (LaRC, DFRC, SSC, and JPL) and MAF do not permit use of the Warning Line and Safety Monitoring System, but go beyond the OSHA minimum and require a physical-restraint fall protection capability, such as a guardrail system, safety net system, or personal fall arrest systems (tie-offs).

**Question 2:** *Explain how your Center's safety requirements for roofing work are flowed down to your prime contractors and their subcontractors. For example, do all your subcontractors use a Centerwide policy for fall protection or are they allowed to bring in their own equipment or plans?*

**Responses:** All ten Centers, plus MAF and WSTF, indicated they had a positive flowdown of safety requirements to their prime contractors and subcontractors. Generally, Center safety requirements (including those for roofing operations) flow down to prime contractors and subcontractors through contractual safety clauses and are implemented through communication in prework meetings, tailgate safety discussions, and periodic safety meetings. Compliance is verified through oversight (safety inspections and surveys) of operations by Federal and contractor safety personnel. Safety requirements are further detailed in the contractor/subcontractor work and safety plans for the specific task. Some Centers allow the subcontractors to bring in additional fall protection equipment as long as it is called out in the safety plan. However, almost all Centers stated that it was the prime contractor's responsibility, not NASA's, to ensure that its subcontractors performed the work in a safe manner and adhered to the Center's safety requirements.

Although all Centers and operating locations have policies that are compliant with OSHA minimum fall protection requirements, some Centers have chosen to go above and beyond the OSHA minimum and have implemented more conservative fall protection policies requiring physical restraints.

#### **3.4.3.4 Training findings for Oneida Construction, Inc.**

The subcontractor (Oneida), according to its contract with SGS, was responsible for certifying that all employees had completed and were current in training that was required by OSHA standards. The OSHA standard identified in the contract, to which the workers were to be trained, was 29 CFR 1926.503, Training Requirements. The training requirements in 29 CFR 1926.503(a)(2) state "The employer shall assure that each employee has been trained, as necessary, by a competent person qualified in 1926 Subpart M, Fall Protection."

It further states in 29 CFR 1926.503(b)(1):

*"The employer shall verify compliance with paragraph (a) of this section by preparing a written certification record. The written certification record shall contain the name or other identity of the employee trained, the date (s) of the training, and the signature of the person who conducted the training or the signature of the employer. If the employer relies on training conducted by another employer or completed prior to the effective date of this section, the certification record shall indicate the date the employer determined the prior training was adequate rather than the date of the actual training."*

For the superintendent, the records provided were certification cards from the local union, which demonstrated that he had received Steel Erection certification and the OSHA 10-hour course, which included Fall Protection subpart M. Oneida records identified the superintendent as having fall protection and fall protection competent-person training. For the deceased and the other Oneida worker, the training information provided by Oneida was a checklist with the workers' names and a certification by the Oneida training coordinator that they had been trained. The training for these workers had been provided by the Oneida training coordinator.

Oneida provided no evidence that either the deceased or the other Oneida worker was trained by a competent person qualified in 29 CFR 1926, Subpart M, Fall Protection. Therefore, the training of the deceased and the other Oneida worker was deficient (Observation 3).

The training certification provided by Oneida was not signed by the trainer or the employer, so it was in technical violation of 29 CFR 1926.503(b)(1) (Observation 4).

#### **3.4.3.5 Training findings for SGS, United Space Alliance (USA), and Boeing**

As part of its request to evaluate fall protection in general at KSC, the Board reviewed the fall protection training given at KSC by SGS, USA, and Boeing.

According to the Gravitec Systems Inc. Fall Hazard Survey, Final Report, October 2005:

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*"The current level of training at KSC is limited to four hours of information. None of the training programs through USA, InDyne, Boeing, and NASA are more than four hours. These four hours may be high quality, however it is not possible to cover basic requirements of fall protection training in this amount of time."*

While KSC fall protection training was, for the most part, adequate for construction workers, it was insufficient for specialized training for competent or qualified persons and inspector training (Observation 5).

**3.4.3.6 Flowdown of Safety Requirements**

The SGS Prime Contract NAS10-99001 contains the following pertinent safety clauses:

- a. Part I, Section H, Special Contract Requirements:  
NASA Clauses: 1852.223-70, Safety and Health
- b. Part II, Contract Clauses, Section I, Clauses Incorporated by Reference
  - (1) Federal Acquisition Regulation (FAR) (48 FR Chapter 1) clauses:
    - (a) 52.222-4, Contract Work Hours & Safety Standards Act
    - (b) 52.223-6, Drug Free Workplace
  - (2) NASA FAR Supplement (48 CFR Chapter 18) Clauses:  
1852.223-74, Drug and Alcohol – Free Workforce

These clauses were flowed down appropriately to the Oncida Construction, Inc., subcontract. Contract clause flowdown to the subcontractor was not a contributing factor to the mishap (Observation 11).

**3.4.3.7 Behaviors identified in mishaps can be used to study and improve the KSC safety culture**

The Board was requested by the appointing official to explore the institutional safety culture at KSC (KSC culture). This subsection discusses interviews with KSC managers, defines culture, and identifies how the events of mishaps may be related to the KSC culture by focusing on observable behaviors.

As an indicator of the KSC culture, the Board discussed safety culture during the interviews of civil-servant and contractor managers. These managers indicated they understood that safety culture begins with and is enforced by the leadership of the organization.

Culture is defined as the attitudes, values, and behaviors that are characteristic of a particular social group or organization, commonly described as "the way we do things here." Behavior can be seen or observed by others, whereas the attitudes, values, beliefs, and perceptions cannot be seen directly.



Although underlying attitudes and values may affect behavior, and therefore culture, they cannot be directly observed or measured. One strategy to understand KSC culture is to focus on the identification of observable behaviors of the people involved in a mishap. A single occurrence of a behavior may not be an indicator of the current culture, but if it is seen consistently, it would be a more likely indicator of the KSC culture. If the behaviors associated with this mishap were compared with behaviors identified in other mishaps, then consistently observed behaviors could be identified and conclusions could be drawn relating to the KSC culture. Actions could then be taken to modify these repeated behaviors to improve the KSC culture.

The following are examples of behaviors from this mishap that could be compared to behaviors observed in other mishaps:

- Employees violated known rules or requirements:
  - Example of behavior: Superintendent helped move the roofing panel while acting as the safety monitor.
  - Example of behavior: Superintendent did not use the warning line.
- Teamwork: Workers did not take action to protect one another.
  - Example of behavior: Coworkers did not stop the superintendent from working while acting as the safety monitor.
  - Example of behavior: Coworkers did not stop the superintendent when he failed to add the warning line.
- Management did not follow up adequately on noncompliances:
  - SGS and Oncida did not apply consequences for previous repeated fall protection violations by the same individual.

It is possible that there may not be one well-defined KSC safety culture, but instead a composite of cultures of different organizations, workgroups, contractors, civil servants, etc. The culture of these individual subgroups could be very different and may have a stronger effect on an individual than the overall KSC culture, so they need to be considered also.

In conclusion, the safety culture of KSC and its subgroups may be affected by identifying the observed behaviors associated with the events and contributing factors for this or other mishaps and taking action to influence the behaviors. Because of limited scope and resources, the Board identified this methodology but did not conduct an analysis.

#### **3.4.4 Items not further developed in the event and causal factor tree**

As factors were developed in the E&CF tree, some were conclusively eliminated as having nothing to do with the mishap. In other cases, the evidence was insufficient to rule out a factor. However, in most of these cases, the evidence that was available indicated that the factor did not play a role in the mishap.

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Some elements could be dismissed at a high level in the tree, but most required delving into lower levels. Some elements were identified as speculation or extrapolations that evidence did not support. These were also eliminated. This subsection pertains to events, conditions, and failed barriers that the Board ruled out as factors in the mishap based on evidence or that were not included because there was not enough evidence to conclude that they were factors.

The Board evaluated various aspects of the working condition to determine if they may have had a role in the mishap. Factors considered included whether the deceased understood his proximity to the roof edge, whether the safety monitor's line of sight was blocked, and whether the safety monitor could have seen the deceased's foot as it got close to the tripping hazard if he (the safety monitor) had been in a better position. The Board determined that there was **not enough evidence** to determine if these were factors.

The Board evaluated various aspects of potential impairment of the deceased, including fatigue, stress, and visual impairment, and determined that these were **not factors** in the mishap.

The Board evaluated whether a push, intentional or inadvertent, occurred and led to the mishap and determined that this was **not a factor**.

The Board evaluated whether environmental conditions, such as wind, temperature, glare, rain, moisture level of the corrugated roof, and noise levels, played a role in the mishap and determined that they were **not factors**.

The Board evaluated various aspects of the decisionmaking by the workers on the roof:

- Time pressure for the entire roofing job and on the day of the mishap was considered and was determined **not a factor**.
- The workers and superintendent may not have perceived the danger of working on the roof because the job was thought to be very simple and quick—the roof was low-height and low-slope, and they had done this type of work often. There was **not enough evidence** to determine if these were factors.
- The superintendent may have thought that he could perform the duties of safety monitor effectively while performing roofing work because he may not have considered that his attention would be diverted from his monitoring task while he helped to lift the panel. There was **not enough evidence** to determine if this was a factor.
- The superintendent knew the rules for using the Warning Line and Safety Monitoring System, but may have chosen to violate the rules because he considered it to be safe and did not expect negative consequences. There was **not enough evidence** to determine if these were factors.
- The other workers did not correct the superintendent when he failed to use the warning line or when he chose to lift the panel while monitoring. It is not known why this occurred, but the Board's discussion included these possibilities: the

other workers may not have felt they had the authority to correct the superintendent; they may have trusted the superintendent's judgment; they had seen him do this in the past with no significant consequences; it may have become an accepted practice by the workers; or the other employees may have been preoccupied with their own tasks, and therefore may not have thought about challenging the decision. In all cases, there was **not enough evidence** to determine if these were factors.

The Board evaluated the method the superintendent and workers selected to move the panel because it put the deceased very close to the leading edge of the roof at the time of the mishap. It appears that the method of moving the panel was coordinated on the spot, with informal verbal communication between the superintendent and the workers. There was **not enough evidence** to determine if this was a factor.

#### **4. SUMMARY OF FINDINGS AND RECOMMENDATIONS**

##### **4.1 Proximate Causes**

The Board has determined that the Building M6-794 roofing fatality resulted from the proximate causes summarized in 4.1.1 and 4.1.2. If either of these were eliminated or modified, this mishap would not have occurred.

##### **4.1.1 Proximate Cause 1: Deceased was working close to the edge of the roof (17 ft above the ground) without proper fall protection**

Oneida personnel were removing and replacing a roofing panel on the northeast corner of Building M6-794. The deceased was working without proper fall protection because the work had been misclassified as low-sloped roofing instead of steel erection, which required physical restraints. For low-sloped roofing work, OSHA allowed use of a Warning Line and Safety Monitoring System in lieu of physical restraints. However, a warning line was not used and the safety monitor was helping the workers instead of acting solely as a safety monitor; both were violations of OSHA regulations for proper fall protection.

##### **4.1.2 Proximate Cause 2: Deceased fell from the roof**

Evidence shows that the deceased either tripped or stumbled prior to falling off the roof, rather than stepped off the roof. The two most likely tripping hazards were the lightning protection wire (located approximately 6 inches from the edge of the roof) and the uneven working surface of the corrugated roof.

##### **4.2 Root Causes and Recommendations**

The Board has determined the root causes for the Building M6-794 roofing fatality. These root causes, along with recommendations to prevent recurrence, are given in 4.2.1 through 4.2.5.

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**4.2.1 Root Cause 1: Oneida was unaware of the OSHA interpretation to classify the work as steel erection (RC1)**

**Background:** From inception, Oneida considered and managed this construction project as if it were a low-sloped roofing project. According to the low-sloped roofing regulations, OSHA permits use of the Warning Line and Safety Monitoring System for fall protection. However, OSHA's interpretation in a November 8, 2002, letter of Standard Interpretation classified this type of work as "steel erection," which prohibits use of the Warning Line and Safety Monitoring System and requires more stringent physical-restraint methods of fall protection. After the mishap, an OSHA investigation determined this particular work to be steel erection.

**Recommendation (RC1-1):** When responding to an RFP and prior to preparing a safety plan, subcontractors should review OSHA regulations and letters of Standard Interpretation to properly classify the work.

- When roofing jobs are performed, subcontractors are responsible for determining the applicability of 29 CFR 1926.501 (low-sloped roof) and 29 CFR 1926.750 (steel erection) in accordance with OSHA Standards and letters of Standard Interpretation.
- Contract language should include information alerting subcontractors that the OSHA Area Office has a compliance assistance specialist available as a resource.

**4.2.2 Root Cause 2: SGS was unaware of the OSHA interpretation to classify the work as steel erection (RC2)**

**Background:** Based upon the OSHA letter of Standard Interpretation and the OSHA postmishap investigation, the Board determined that Oneida misclassified the work as low-sloped roofing instead of steel erection. SGS did not inform Oneida that the work was steel erection because SGS also misclassified the work. Adherence to and implementation of the more stringent fall protection requirements for steel erection described in 29 CFR 1926, Subpart R, may have prevented the mishap. Both Oneida and SGS were unaware of the OSHA letter of Standard Interpretation to classify the work as steel erection until OSHA conducted its postmishap investigation.

**Recommendation (RC2-1):** Prior to issuing an RFP, the prime contractor should review OSHA regulations and letters of Standard Interpretation to properly classify work.

- When roofing jobs are performed, contractors are responsible for determining the application and applicability of 29 CFR 1926.501 (low-sloped roof) and 29 CFR 1926.750 (steel erection) in accordance with OSHA Standards and letters of Standard Interpretation.
- Contract language should include information alerting subcontractors that the OSHA Area Office has a compliance assistance specialist available as a resource.

**Recommendation (RC2-2):** NASA/KSC and prime contractors should review current ongoing work involving roofing to ensure proper work classification and compliance with OSHA Standards and letters of Standard Interpretation.

**4.2.3 Root Cause 3: Oneida did not ensure its superintendent's compliance with the OSHA requirement for fall protection (RC3)**

**Background:** Oneida considered this work to be low-sloped roofing and was using a Warning Line and Safety Monitoring System as fall protection. The Oneida superintendent failed to use a warning line, in violation of OSHA regulations for low-sloped roofs. He also helped move a roofing panel while acting as safety monitor, also an OSHA violation. Although SGS had previously written up the superintendent for warning line and safety monitor noncompliances, the Board had no evidence to suggest these noncompliances were ever presented to the Oneida owner/president. The Board determined that trend analysis of nonconformances could have identified this issue; however, the Board found no evidence that SGS had performed any trend analysis of nonconformances.

**Recommendation (RC3-1):** Prime contractors should develop a mechanism to ensure that OSHA noncompliances immediately dangerous to life and health are reported to the subcontractor president/top management.

**4.2.4 Root Cause 4: SGS did not ensure Oneida's compliance with the OSHA requirement for fall protection (RC4)**

**Background:** SGS allowed Oneida workers to perform roofing work without proper fall protection. The Oneida superintendent failed to use a warning line, in violation of OSHA regulations for low-sloped roofs. He also helped move a roofing panel while acting as safety monitor, also an OSHA violation. Although SGS had previously written up the superintendent for warning line and safety monitor noncompliances, no contractual action was taken by SGS toward Oneida. Also, the Board had no evidence to suggest these noncompliances were ever presented to the Oneida owner/president. The Board determined that trend analysis of nonconformances could have identified this issue; however, the Board found no evidence that SGS had performed any trend analysis of nonconformances.

**Recommendation (RC4-1):** SGS should develop a mechanism to ensure that OSHA noncompliances immediately dangerous to life and health are reported to the subcontractor president/top management.

- Other prime contractors (e.g., USA and Boeing) should develop a similar mechanism to ensure that OSHA noncompliances immediately dangerous to life and health are reported to the subcontractor president/top management.
- For construction contracts that NASA/KSC issues, NASA/KSC should develop a similar mechanism to ensure that OSHA noncompliances immediately dangerous to life and health are reported to the contractor president/top management.

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**Recommendation (RC4-2):** Prime contractor safety specialists should trend noncompliances and discuss them at the appropriate contractor/subcontractor safety meeting.

**Recommendation (RC4-3):** For construction contracts that NASA/KSC issues, NASA/KSC should trend noncompliances and discuss them at the appropriate contractor safety meeting.

**4.2.5 Root Cause 5: NASA/KSC fall protection practices follow the OSHA-defined standards for low-sloped roofs, which allow the Warning Line and Safety Monitoring System rather than requiring a physical-restraint system. (RC5)**

**Background:** Although allowed by OSHA for low-sloped roofing work, the Warning Line and Safety Monitoring System has no physical means of limiting a fall. While a physical-restraint system will not necessarily eliminate all injuries, if properly used, it will eliminate the human error associated with using a Warning Line and Safety Monitoring System.

**Recommendation (RC5-1):** NASA/KSC should develop and implement a fall protection policy and program for low-sloped roofing work that is more stringent than the OSHA standard and requires the use of physical restraints when working within 6 ft of the edge. The use of warning lines and safety monitors or other nonphysical-restraint systems should be reserved for special circumstances after review and approval through a NASA/KSC formalized variance process.

**Recommendation (RC5-2):** A Centerwide fall protection team (civil servants and contractors) should be formed to examine issues (e.g., standardization across contractors, variance processing, retrofitting of existing facilities) arising from the implementation of a new, more stringent fall protection policy and program.

**4.3 Contributing Factors**

Several factors were found to contribute to the events and conditions that led to the Building M6-794 roofing fatality. These contributing factors, along with recommendations, are given in 4.3.1 through 4.3.4.

**4.3.1 Superintendent helped move the roofing panel while acting as the safety monitor (CoF1)**

**Background:** The Oneida superintendent was acting as the safety monitor, a function with the following OSHA responsibilities: (1) the safety monitor shall be competent to recognize fall hazards; (2) the safety monitor shall warn the employee when it appears that the employee is unaware of a fall hazard or is acting in an unsafe manner; (3) the safety monitor shall be on the same walking/working surface and within visual sighting distance of the employee being monitored; (4) the safety monitor shall be close enough to communicate orally with the employee; and (5) *the safety monitor shall not have other responsibilities that could take the monitor's attention from the monitoring function* (emphasis added). However, the superintendent physically assisted the workers by helping them move the roofing panel, while acting as the safety monitor.

Note: This contributing factor was analyzed further and the result led to Root Causes 3 and 4. See 4.2.3 and 4.2.4.

**4.3.2 Superintendent did not stop the job and seek additional personnel when two workers were not sufficient (CoF2)**

**Background:** While replacing two other panels earlier that day on the same roof, the superintendent recognized a hazard to the fingers of the person lifting the leading edge of the adjacent sheet metal. As the workers slid the new sheet underneath the adjacent sheet while holding the edge up, their fingers were being pinched. By having a third person hold up the edge of the adjacent sheet, the pinch point hazard was eliminated. The superintendent did not stop the job and seek additional personnel to help with the third roofing panel when two workers were not sufficient. Instead of keeping himself free of other functions to act as safety monitor, or stopping the job and seeking additional personnel, he assisted the workers with their task. The Board concluded that the superintendent performed his duties improperly by not stopping the job and seeking additional personnel when two workers were not sufficient.

**Recommendation (CoF2-1):** Prime contractors should investigate providing incentives to subcontractors for safe work; similar to how NASA/KSC provides monetary award for safety performance to its construction contractors.

**4.3.3 Temporary anchorage points were not required by OSHA, NASA, KSC or contractors (CoF3)**

**Background:** There is no evidence that temporary anchorage points, which could have been provided by Oneida, were ever considered prior to the roofing job commencing. In fact, the Oneida safety plan, which permitted the use of the Warning Line and Safety Monitoring System, was properly submitted and approved by SGS Safety, Health, and Training in accordance with SGS OSH-P-0215, Construction and Service Subcontractor Safety Program, and as written, complied with OSHA, NASA, KSC, and contractor safety requirements for low-sloped roofing work. It should be noted that after the mishap, a temporary fall protection system (life lines) was installed to allow the roofing job to be completed.

**Recommendation (CoF3-1):** A Centerwide fall protection team (civil servants and contractors) should be formed to examine issues (e.g., use of temporary anchorage points, standardization across contractors, variance processing, retrofitting of existing facilities) arising from the implementation of a fall protection policy and program.

**4.3.4 While not legally intoxicated under Florida's Driving Standard, the deceased was under the influence of alcohol and tested positive for marijuana (CoF4)**

**Background:** The deceased was impaired at the time of the mishap since he tested positive for the presence of alcohol and tetrahydrocannabinol (THC), a marijuana metabolite. Physical impairment of the deceased by drugs or alcohol could have increased the likelihood of his tripping, stumbling, or losing his balance; or upon tripping, stumbling, or losing his balance, being less able to regain his balance. The regulations as written in the NASA Drug Free Workplace Program (NPR 3792.1A, NASA Plan for a Drug-Free Workplace, for civil servants;

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and the NASA FAR supplement section on Drug-Free Workplace for contractors) did not require drug or alcohol testing for the individuals involved in this mishap, either as a part of random screening or postmishap.

**Recommendation (CoF4-1):** NASA Headquarters should evaluate the requirements of the NASA Drug-Free Work Place Program and the NASA FAR Supplement, section on Drug-Free Workplace for contractors, to determine whether they are adequate to protect the civil-service and contractor workforce.

#### 4.4 Failed Barriers

The Board found one failed barrier associated with the Building M6-794 roofing fatality. This failed barrier is discussed in 4.4.1.

##### 4.4.1 Superintendent did not use the Warning Line and Safety Monitoring System correctly (FB1)

**Background:** The Warning Line and Safety Monitoring System, which was permitted by OSHA 29 CFR 1926.501(b)(10) for work on low-sloped roofs, was not properly implemented by the Oneida superintendent. Two OSHA violations occurred because the superintendent (1) did not use a warning line and (2) helped the Oneida workers carry the roofing panel, while acting as the safety monitor.

**Recommendation:** See Recommendation RC5-1.

#### 4.5 Other Significant Observations and Recommendations

##### *Training and Documentation*

##### 4.5.1 Oneida did not maintain a current list of employees who were working on the job site (O1)

**Recommendation (O1-1):** SGS should ensure that its subcontractors maintain a current list of all employees working on the job site.

- Employee lists should be kept at job sites for review by SGS. Subcontractor site supervisors should update employee lists as new employees come onto a job site.
- Subcontractor should verify current training records and/or certifications for each employee on this list.

##### 4.5.2 Oneida did not conduct, or did not document, all weekly safety meetings (O2)

**Recommendation (O2-1):** SGS should ensure that subcontractor site superintendents comply with safety meeting and documentation requirements as set forth in their contracts.



- 4.5.3 Oneida provided no evidence that either the deceased or the other Oneida worker was trained by a competent person qualified in 29 CFR 1926, Subpart M, Fall Protection. Therefore, the training of the deceased and the other Oneida worker was deficient (O3)

**Recommendation (O3-1):** SGS should ensure that Oneida retrain all its employees who perform work for KSC in required elements of fall protection. Proof of training by a competent and qualified person should be provided.

**Recommendation (O3-2):** A Centerwide fall protection team should develop minimum standards or elements of fall protection training for use by KSC construction contractors and subcontractors as they develop their training requirements.

- 4.5.4 The training certification provided by Oneida was not signed by the trainer or the employer, so it was in technical violation of 29 CFR 1926.503(b)(1) (O4)

**Recommendation (O4-1):** SGS should evaluate methods of enforcing the 29 CFR 1926.503(b)(1) requirement for its subcontractors.

- 4.5.5 While KSC fall protection training was, for the most part, adequate for construction workers, it was insufficient for specialized training for competent or qualified persons and inspector training (O5)

**Background:** As part of its request to evaluate fall protection in general at KSC, the Board reviewed the fall protection training given at KSC by SGS, USA, and Boeing. According to the Gravitec Systems Inc. Fall Hazard Survey, Final Report, October 2005, "The current level of training at KSC is limited to four hours of information. None of the training programs through USA, InDyne, Boeing, and NASA are more than four hours. These four hours may be high quality, however it is not possible to cover basic requirements of fall protection training in this amount of time."

**Recommendation (O5-1):** A Centerwide fall protection team should evaluate KSC fall protection training programs to ensure that training is appropriate and adequate to train personnel to be "competent and qualified" as defined in 29 CFR 1926.32.

#### *Communications*

- 4.5.6 Contractors and subcontractors were not required to inform NASA of all on-Center worksite OSHA noncompliances (O6)

**Recommendation (O6-1):** NASA/KSC should determine if the existing policy, which does not require NASA/KSC to be informed of all worksite safety noncompliances, is adequate.

- 4.5.7 Inadequate coordination within SGS resulted in Oneida working without the knowledge of SGS Safety (O7)

**Recommendation (O7-1):** SGS should ensure proper coordination among all elements of SGS and subcontractors prior to start of work (i.e., before permission to return to work is granted to

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subcontractors, confirmation should be obtained from each SGS organization required to monitor subcontractor performance).

*Fall Policy*

- 4.5.8 Permanent anchorage points were not added anytime after the initial construction of Building M6-794, and KSC policy did not require their installation (O8)**

Neither permanent nor temporary anchorage points were available or made available on Building M6-794 at the time of the mishap. The Board determined that permanent anchorage points were not part of the original 1964 design of M6-794. Since that time, permanent anchors were not added, and KSC policy did not require their installation.

**Recommendation (O8-1):** A Centerwide fall protection team (civil servants and contractors) should consider the policy of adding permanent anchorage points on new construction projects at KSC and retrofitting existing facility roofs with permanent fall protection systems based on a hierarchy of need (e.g., roof access frequency, presented hazards).

- 4.5.9 Other than OSHA minimum standards, no single, standardized fall protection policy exists across all NASA Centers or operating locations (O9)**

**Recommendation (O9-1):** NASA's Office of Safety and Mission Assurance (OSMA) should take the lead in convening an inter-Center team of safety and fall protection experts to make recommendations concerning a uniform fall protection policy for the Agency.

*Other*

- 4.5.10 Drug and alcohol testing was not performed on Oneida workers involved in the mishap (O10)**

**Background:** The regulations as written in the NASA Drug Free Workplace Program (NPR 3792.1A, NASA Plan for a Drug-Free Workplace, for civil servants; and the NASA FAR supplement section on Drug-Free Workplace for contractors) did not require drug or alcohol testing for the individuals involved in this mishap, either as a part of random screening or postmishap.

**Recommendation (O10-1):** NASA Headquarters should revise the NASA Drug Free Workplace Program (NPR 3792.1A, NASA Plan for a Drug-Free Workplace, for civil servants; and the NASA FAR supplement section on Drug-Free Workplace for contractors) to include postmishap drug and alcohol testing for all contractor, subcontractor, and Government employees involved in Type A and Type B mishaps.

**Recommendation (O10-2):** The Center Safety Office should develop a checklist of activities for the Incident Response Team (IRT) to ensure all critical elements of a mishap investigation, including testing for drugs and alcohol in a Type A or Type B mishap, are accomplished.

**4.5.11 Contract clause flowdown to the subcontractor was not a contributing factor to the mishap (O11)**

**Recommendation (O11-1):** None. The SGS Prime Contract NAS10-99001 contained all pertinent safety clauses. The SGS safety clauses flowed down appropriately to the Oneida subcontract. Contract clause flowdown was not considered a contributing factor to the mishap.

**4.5.12 Behaviors identified in mishaps can be used to study and improve the KSC safety culture (O12)**

**Background:** Some behaviors observed in this mishap may be similar to those in other recent mishaps at KSC. One isolated occurrence of a behavior may not reflect the safety culture, but consistent recurrences of similar behaviors may be stronger indications of systemic safety culture issues. Once identified, actions can then be taken to modify at-risk behaviors, which may indirectly change the culture of KSC and its subgroups.

**Recommendation (O12-1):** A NASA/KSC team should identify a consistent method of categorizing behavioral contributing factors to mishaps, considering the various models used at KSC and in industry. This can be used for two purposes:

- **Recent mishaps:** Identify similar at-risk behaviors that led to recent mishaps and develop a plan to reduce these behaviors at KSC. This may have long-term effects on the KSC safety culture.
- **Future mishaps:** Use this method of categorizing behavioral contributing factors in future mishaps to improve trending and reduce at-risk behaviors. Ensure that future mishap boards consider cultural issues from the beginning by identifying how to include culture in mishap investigation reports. Define specifically what should and should not be included in mishap reports regarding culture.

## APPENDIX A. REFERENCES

1. 29 CFR 1926, OSHA Construction Industry Regulations.
2. KNPR 8715.3, KSC Safety Practices Procedural Requirements, Revision B-1, February 8, 2006.
3. NPR 8621.1A, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping.
4. Space Gateway Support (SGS), Inc. Contract "Joint Base Operations and Support Contract," October 1, 1998.
5. SGS Construction Subcontract X04524, "Oneida Indefinite Delivery Indefinite Quantity (IDIQ) Subcontract," May 10, 2004.
6. SGS Request for Proposal (RFP) No. X04524, X04525, X04526, X04527 and X04528, "High Wind Resistance Roof Repairs, Bldg. M6-0794, Supply Warehouse #1, KSC," July 25, 2005.
7. Design Package 98K04007, "High Wind Resistance Roof Repairs, Kennedy Space Center Florida, for building M6-0794, Supply Warehouse #1."
8. SGS Subcontract No. X04524-6, Supplemental Agreement Modification No. 23, "High Wind Resistance Roof Repairs, Bldg. M6-0794, Supply Warehouse #1, KSC," September 15, 2005.
9. Approved Oneida Safety Plan X04524-6, Transmittal #2, September 23, 2005.
10. KSC Fall Protection Hazard Survey, October 2005, (Gravitec Systems Inc.).
11. Oneida Construction, Inc., Safety Plan (Corporate), Rev. 10, January 2004.
12. Training records for Oneida Superintendent (through Ironworkers Local Union No. 808).
13. Oneida Training Certifications for deceased and other workers.
14. SGS Daily Construction Reports, 21 pages.
15. SGS Daily Construction & Services Subcontractor Checklist (Safety) for Oneida Subcontracts X04524-6, X05539, X00548, X00558, X04510, X04522, X05536, X05541, and X05556.
16. Oneida Daily Log of Construction, 20 pages.
17. U.S. DOL, OSHA, Standards of Interpretation, November 8, 2002.
18. Oneida Drug-Free Workplace Policy Statement.
19. NASA Mishap Report, Form 1627, March 20, 2006.
20. Incident Reporting Information System (IRIS) #2006-079-00003.
21. OSHA 300a log for Oneida.
22. Draft SGS Supply Warehouse #1 Roof Repair Incident Facility M6-0794 Mishap Investigation Report, May 5, 2006.
23. Report of the Office of the Medical Examiner, District 9, Florida.

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## APPENDIX B. DEFINITIONS

The following definitions apply in the context of this document.

**barrier (failed barrier)**

physical device, intervention (e.g., a guardrail), or administrative control that can provide procedural separation in time and space (e.g., lock-out/tag-out procedure) to reduce the risk of an undesired outcome to an acceptable level

**causal factor**

event or condition that results in an effect or that shapes or influences an outcome

**competent person**

one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them (29 CFR 1926.32(f))

**condition**

any as-found state, whether or not resulting from an event, that may have safety, health, quality, security, operational, or environmental implications

**contributing factor**

event or condition that may have contributed to the occurrence of an undesired outcome but, if eliminated or modified, would not by itself have prevented the occurrence

**event**

real-time occurrence describing one discrete action, typically an error, failure, or malfunction (e.g., pipe broke, power lost, lightning struck, person opened valve)

**event and causal-factor tree**

visual representation of causal linkages, where the undesired outcome is at the top, flowing down through proximate causes and intermediate causes to root causes

**finding**

conclusion, positive or negative, based on facts established during the investigation by the investigating authority (e.g., cause, contributing factor, and observation)

**observation**

factor, event, or circumstance identified during the investigation that did not contribute to the mishap or close call, but if left uncorrected, has the potential to cause a mishap or increase the severity of a mishap; or factor, event, or circumstance that is positive and should be noted

**organizational factor**

any operational or management structural entity that exerts control over the system at any stage in its life cycle, including but not limited to the system's concept development, design, fabrication, test, maintenance, operation, and disposal (e.g., resource management [budget, staff, training], policy [content, implementation, verification], and management decisions)

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**proximate cause**

event that occurred or condition that existed immediately before the undesired outcome, directly resulted in the occurrence of the undesired outcome, and if eliminated or modified, would have prevented the undesired outcome

**qualified person**

one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project (29 CFR 1926.32(m))

**recommendation**

action developed by the investigation authority to correct a cause or a deficiency identified during the investigation

**root cause**

event, condition, or organizational factor that contributed to or created the proximate cause and subsequent undesired outcome, and if eliminated or modified, would have prevented the undesired outcome (typically multiple root causes contribute to an undesired outcome)

**warning line**

a barrier erected on roof to warn employees that they are approaching an unprotected roof side or edge and that designates an area in which roofing work may take place without the use of guardrail, body belt, or safety net system

APPENDIX C. ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ARC	Ames Research Center
BAC	blood alcohol content
CAD	computer-aided dispatch
CCAFS	Cape Canaveral Air Force Station
CDZ	control decking zone
CFR	Code of Federal Regulations
DFRC	Dryden Flight Research Center
E&CF	events and causal factors
EMS	Emergency Medical Services
EST	Eastern Standard Time
F/R	Fire/Rescue
ft	foot
GRC	Glenn Research Center
GSFC	Goddard Space Flight Center
IAT	Incident Analysis Technique
IRT	Incident Response Team
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KSC	Kennedy Space Center
LaRC	Langley Research Center
m	meter
MAF	Michoud Assembly Facility
MORT	Management Oversight Risk Tree
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
ORMC	Orlando Regional Medical Center
OSHA	Occupational Health and Safety Administration
OSMA	Office of Safety and Mission Assurance
PAFB	Patrick Air Force Base
RFI	Request for Information
RFP	Request for Proposal



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SGS	Space Gateway Support
SH&T	Safety, Health & Training
SSC	Stennis Space Center
THC	tetrahydrocannabinol
WSFC	White Sands Test Facility

APPENDIX D. OSHA'S FORM 301 COMPLETED FOR THE  
BUILDING M6-794 ROOFING FATALITY

OSHA's Form 301  
Injuries and Illnesses Incident Report

Attention: This form contains information relating to workplace health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

This injury and illness incident report is one of the first forms you must fill out when a recordable work-related injury or illness has occurred. Together with the Log of Work-Related Injuries and Illnesses and the accompanying Summary, these forms help the employer and OSHA develop a picture of the extent and severity of work-related incidents.

Within 7 calendar days after you receive information that a recordable work-related injury or illness has occurred, you must fill out this form or an equivalent. Some state workers' compensation, insurance, or other reports may be acceptable substitutes. To be considered an acceptable form, any substitute must contain all the information asked for on this form.

According to Public Law 94-496 and 29 CFR 1904, OSHA's recordkeeping rule, you must keep this form on file for 4 years following the year to which it pertains.

If you need additional copies of this form, you may photocopy and use as many as you need.

Completed by	PROJECT MANAGER
Title	PROJECT MANAGER
Phone	507-233-0000
Date	5/03/06

Public reporting burden for this collection of information is estimated to average 12 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington, DC 20503. Do not send this collection of information to the person to whom you are sending the form.

Information about the employee

- 1) Full Name JOHN J. BROWN
- 2) Street 12345 MAIN ST
- City ORLANDO State FL Zip 32801
- 3) Date of birth 06/15/1980
- 4) Date hired 06/15/2000
- 5) ☒ Male  
☐ Female

Information about the physician or other health care professional

- 6) Name of physician or other health care professional DR. J. B. SMITH
- 7) If treatment was given on any form the records, what was it given?  
Facility ORLANDO REGIONAL
- Street 12345 MAIN ST
- City ORLANDO State FL Zip 32801

- 8) Was employee treated in an emergency room?  
☒ Yes  
☐ No
- 9) Was employee hospitalized overnight as an in-patient?  
☒ Yes  
☐ No

Information about the case

- 10) Case number from the Log 12345
- 11) Date of injury or illness 5/17/06
- 12) Time employee began work 8:00 AM
- 13) Time of event 1:10 PM
- 14) What was the employee doing just before the accident, equipment or material the employee used, while carrying out his/her job?  
LIFTING ROOF PANEL TO PUT INTO POSITION FOR INSTALLATION
- 15) What happened? Tell us how the injury occurred, what he fell 20 feet; "He was sprayed with a 'water' developed stream in front of him."
- 16) What was the injury or illness? Tell us the part affected, he was sprayed with "water", "hand", "carpal tunnel syndrome."
- 17) What object or article not directly involved the "water" was seen? If this question does not apply?
- 18) If the employee died, when did death occur?  
5/17/06

95/07/2006 28:10 2127206

OSHA CONSTRUCTION

Page 01/01

Building M6-794 Roofing Fatality  
Type A Mishap

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APPENDIX E. INTERIM SAFETY ALERT

From: Stamatelatos, Michael G. (HQ-GD000)  
Sent: Wednesday, April 05, 2006 1:54 PM  
To: DL-HQ-OSMA-SMADIR  
Cc: Oconnor, Bryan (HQ-GA000); Lloyd, James W. (JPL-343F)[JPL]  
Subject: Safety Message - Fall Prevention

Dear SMA Directors:

As a reminder for mishap prevention, the President of the investigation board of the recent mishap in Florida, has asked that the message below be sent throughout the Agency.

Best Regards,  
Michael

Fall Protection Alert "Safety Monitoring System"

All Centers as part of their contractor oversight function are to insure that all prime and sub-contractors are following the OSHA requirements (or the Center's, if more restrictive) for fall protection. In particular, when working on a low slope roof or any similar structure at height (slope less than or equal to 4:12, vertical rise: horizontal run) and using the safety monitoring system, "The safety monitor shall not have other responsibilities which could take the monitor's attention from the monitoring function" (OSHA 29 CFR 1926.502 (h) (1) (v))

\*\*\*\*\*  
Dr. Michael Stamatelatos, Director  
Safety and Assurance Requirements Division  
Office of Safety and Mission Assurance  
NASA Headquarters  
300 E Street, SW  
Washington, DC 20546  
Phone: 202/358-1668 Fax: 202/358-3104  
\*\*\*\*\*

Building M6-794 Roofing Fatality  
Type A Mishap

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APPENDIX F. EVENT & CAUSAL-FACTOR TREE (RELEX)

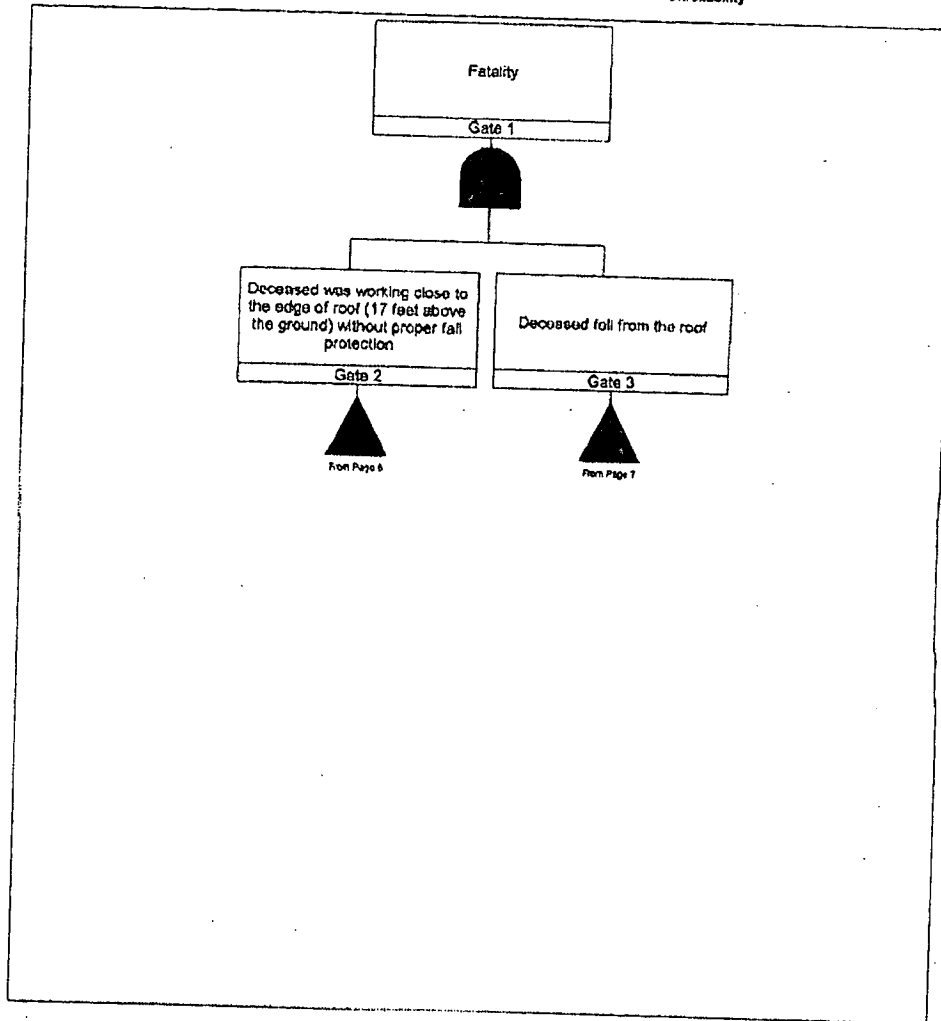
Relox Software Report

*Fault Tree Diagram*

5

File Name E\_CFTree (2008-08-11).RPJ  
Top Gate Name Gate 1

Unavailability  
Unreliability



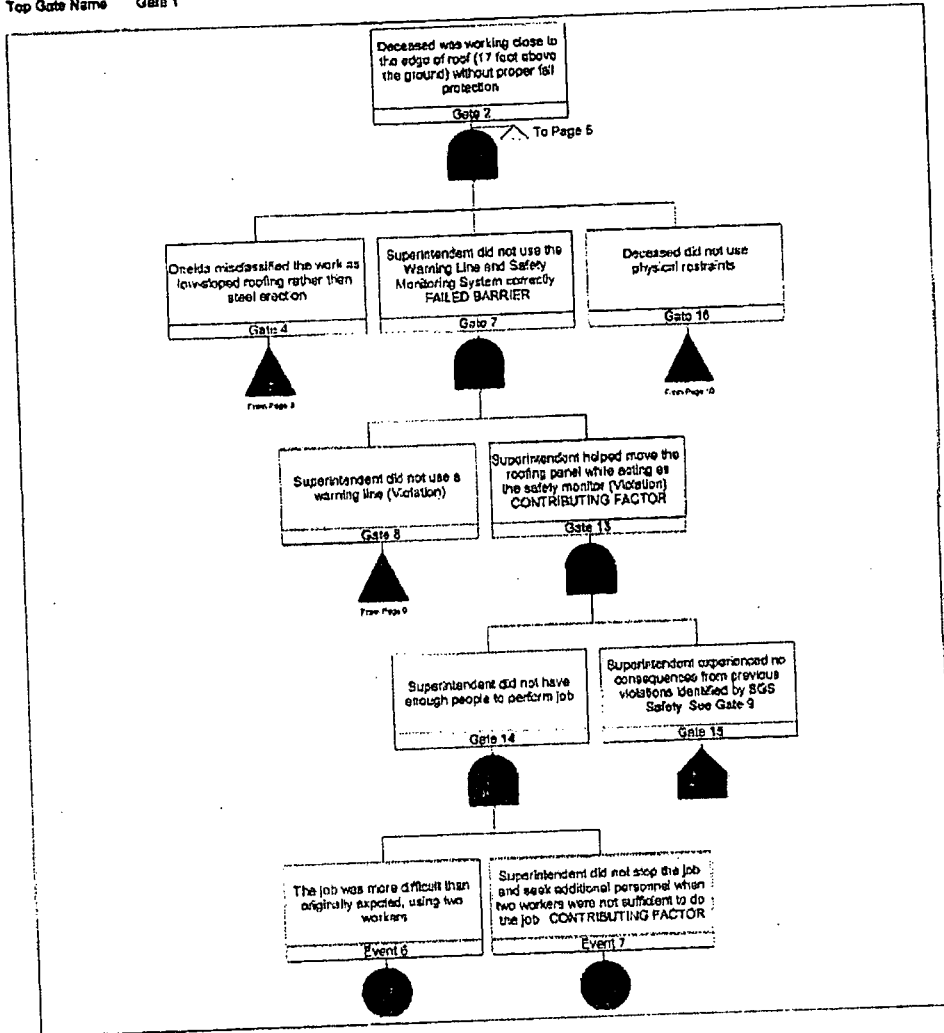
# Building M6-794 Roofing Fatality Type A Mishap

Relox Software Report

## Fault Tree Diagram

File Name E\_CFTree (2008-05-11).RPJ  
Top Gate Name Gate 1

Unavailability  
Unreliability

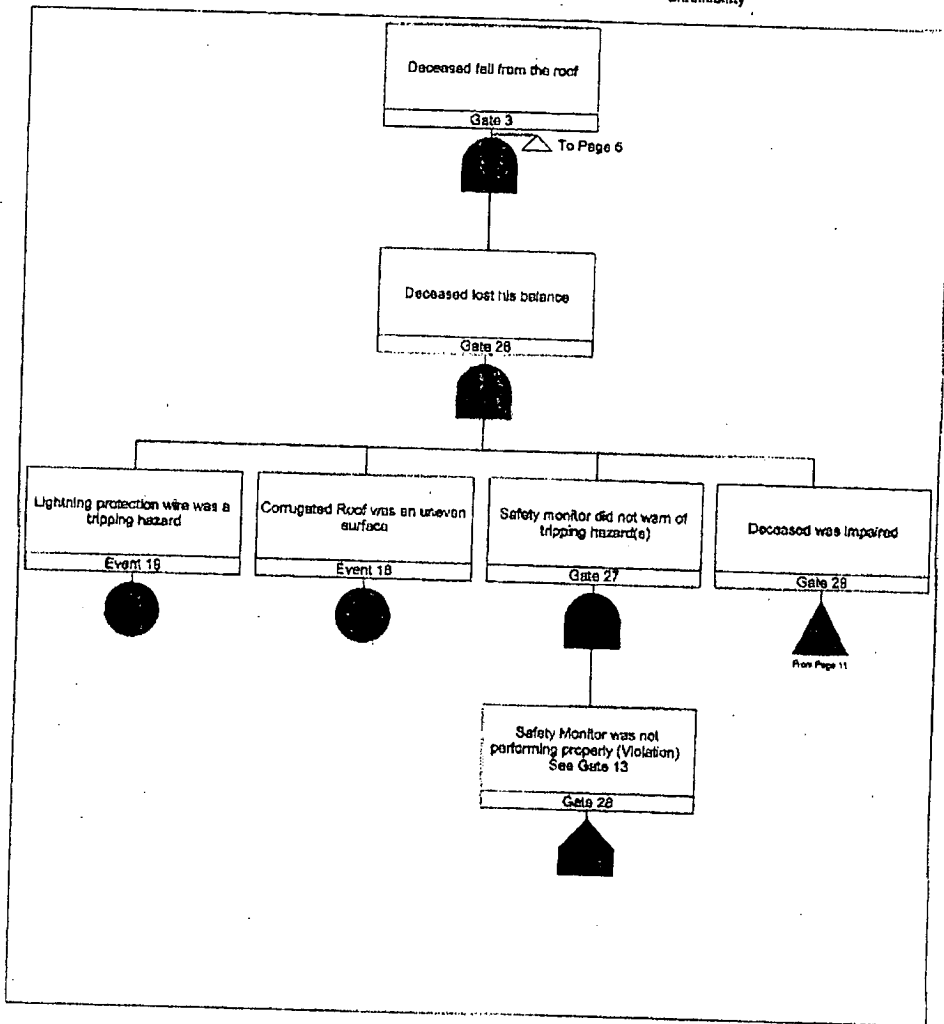


Relix Software Report

File Name E\_CFTree (2006-05-11).RPJ  
Top Gate Name Gate 1

**Fault Tree Diagram**

Unavailability  
Unreliability





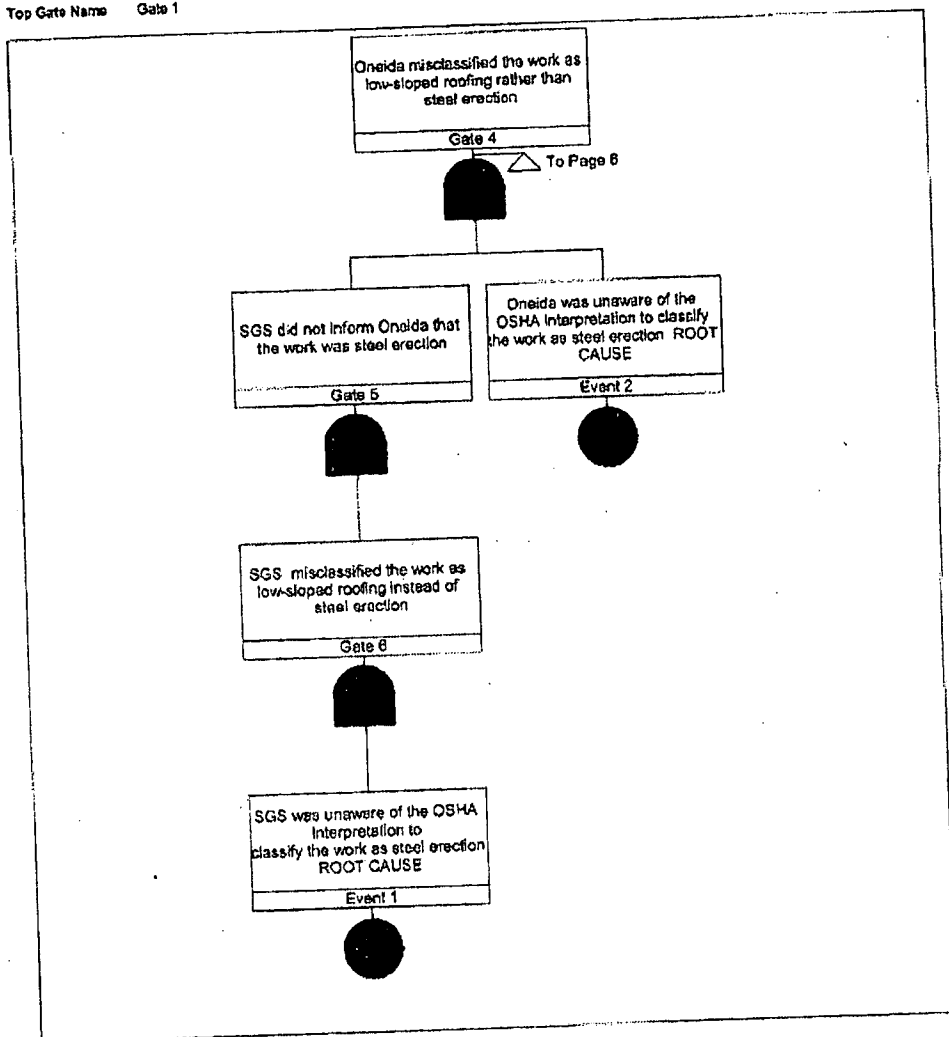
# Building M6-794 Roofing Fatality Type A Mishap

Relix Software Report

## Fault Tree Diagram

File Name E\_CFTree (2008-05-11).RPJ  
Top Gate Name Gate 1

Unavailability  
Unreliability

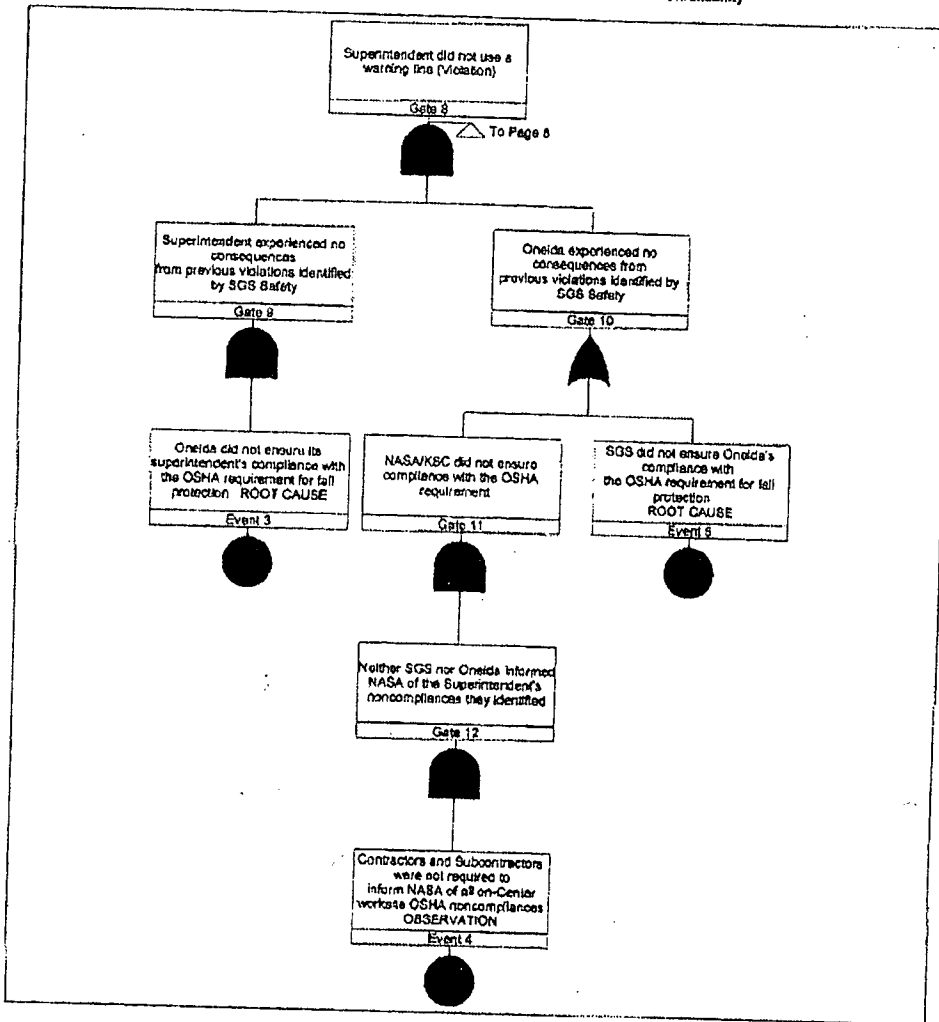


Relax Software Report

File Name E\_CFTree (2006-05-11).RPJ  
Top Gate Name Gate 1

### Fault Tree Diagram

Unavailability  
Unreliability



# Building M6-794 Roofing Fatality Type A Mishap

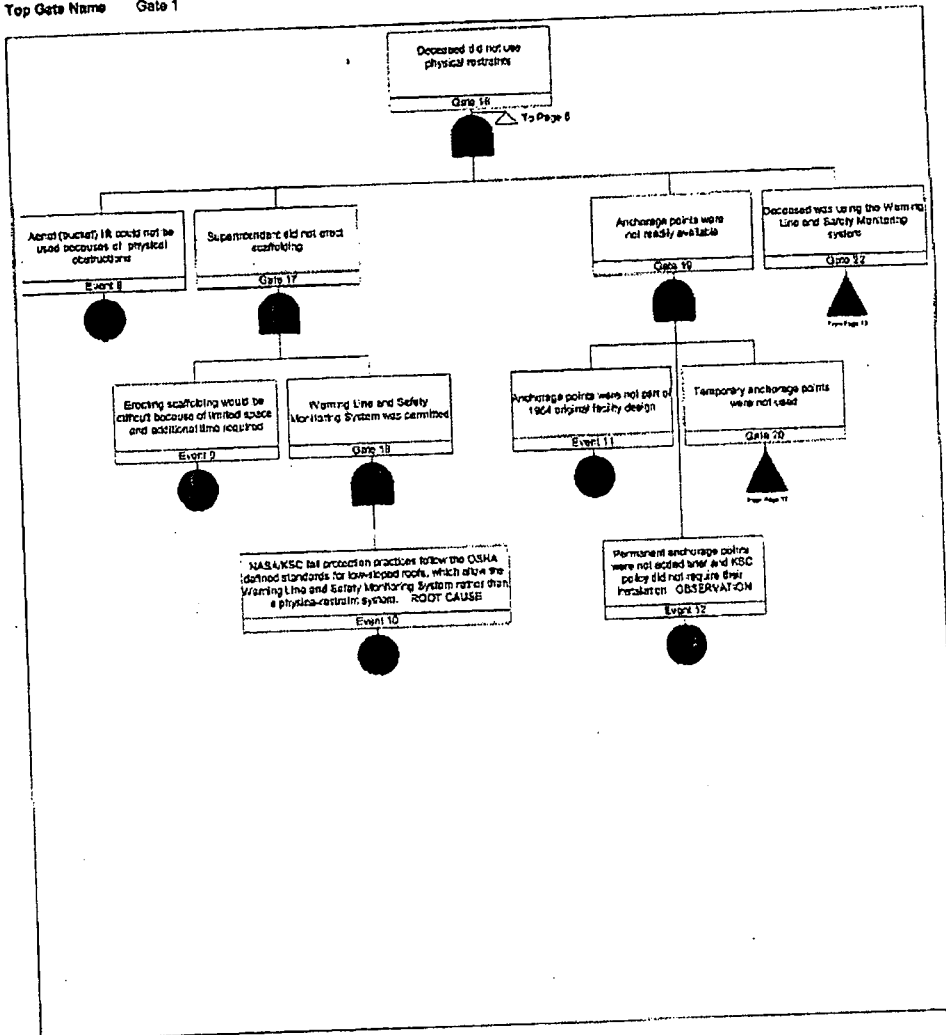
Relief Software Report

## Fault Tree Diagram

Unavailability  
Unreliability

File Name E\_CFTree (2008-05-11).RPJ  
Top Gate Name Gate 1

10



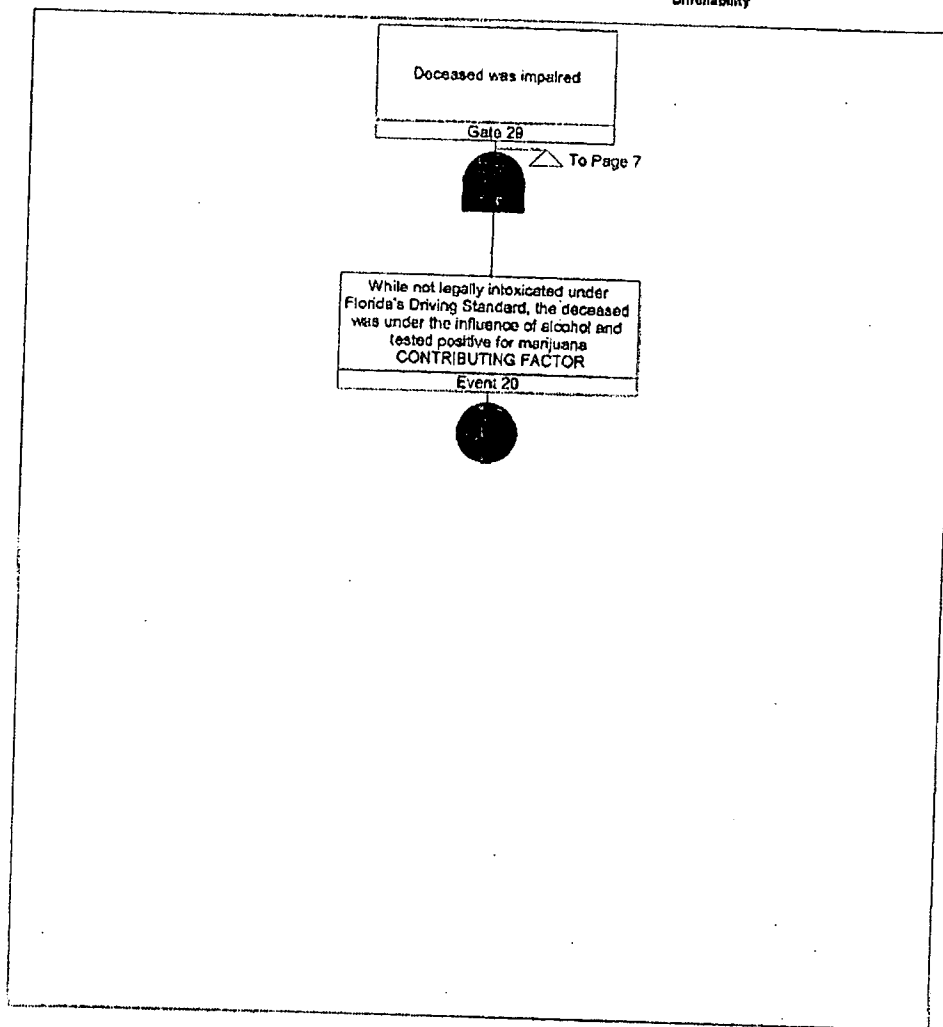
Relax Software Report

**Fault Tree Diagram**

11

File Name E\_CFTree (2006-05-11).RPJ  
Top Gate Name Gate 1

Unavailability  
Unreliability



# Building M6-794 Roofing Fatality Type A Mishap

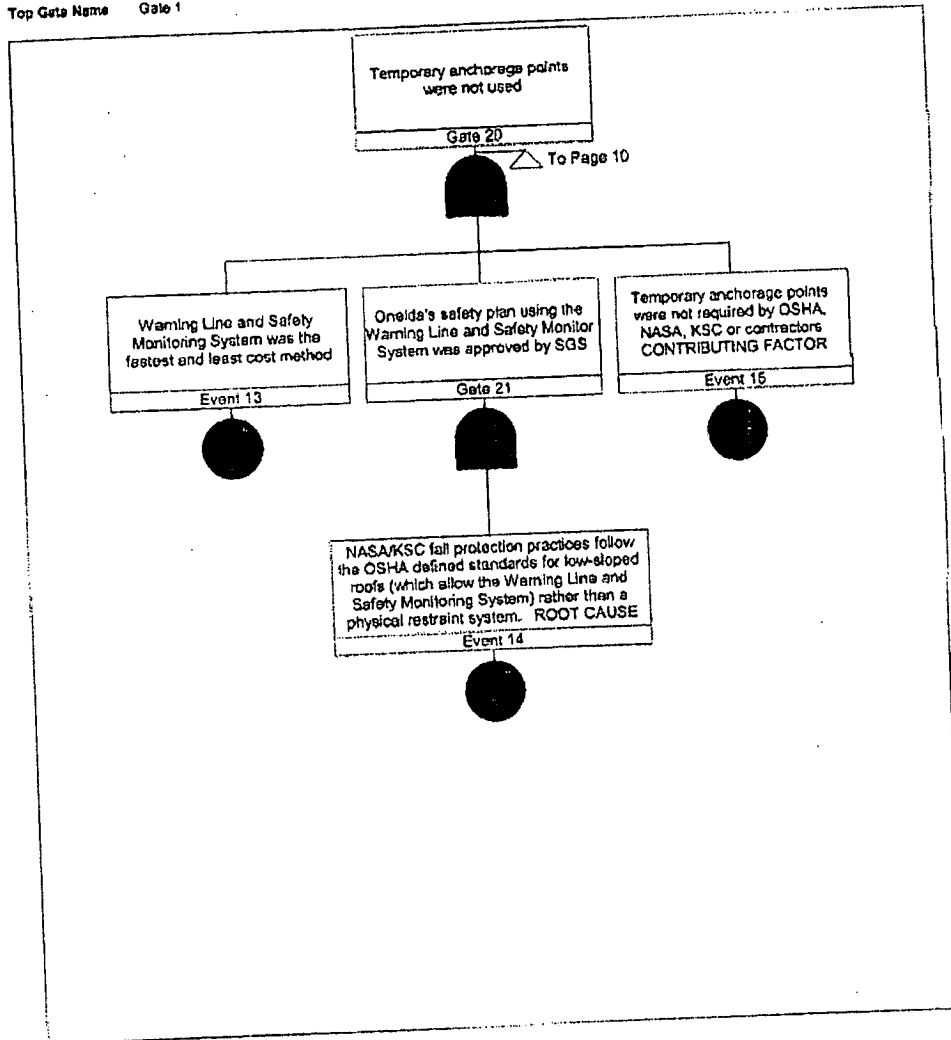
Relax Software Report

## Fault Tree Diagram

Unavailability  
Unreliability

File Name E\_CFTree (2008-05-11).RPJ  
Top Gate Name Gate 1

12



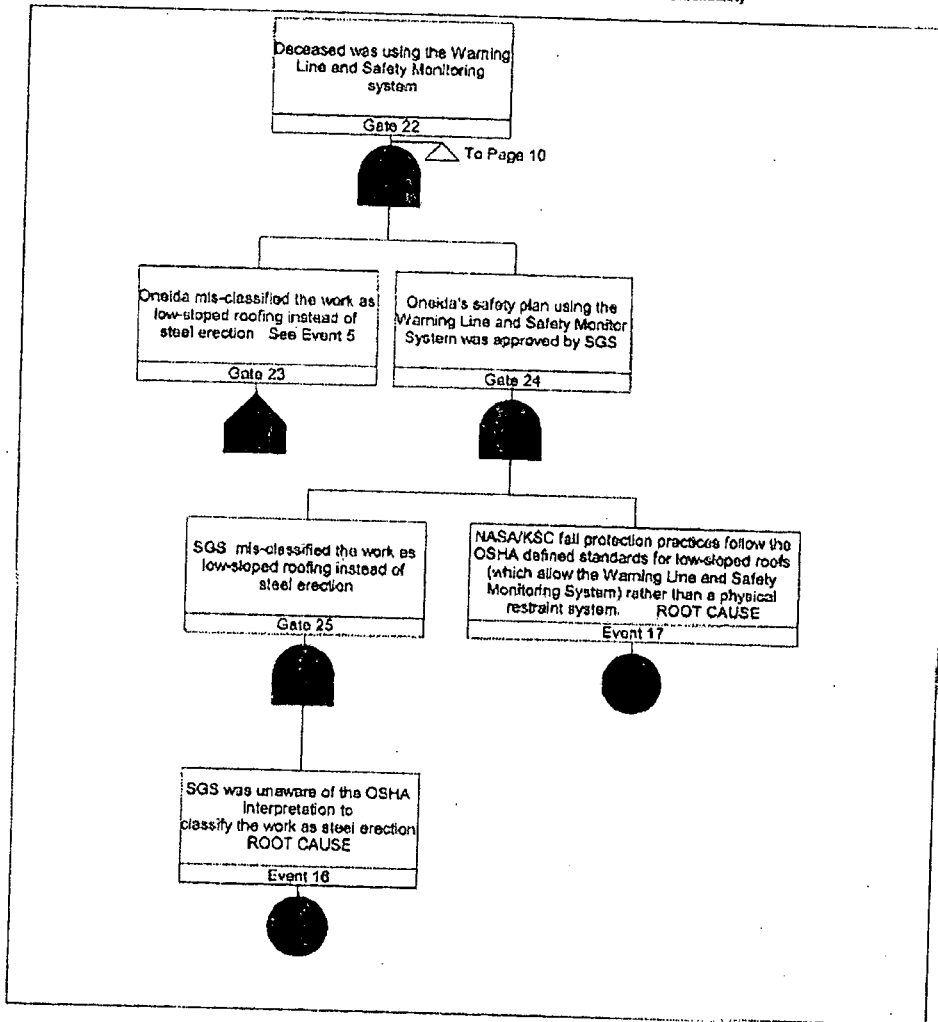
Relax Software Report

**Fault Tree Diagram**

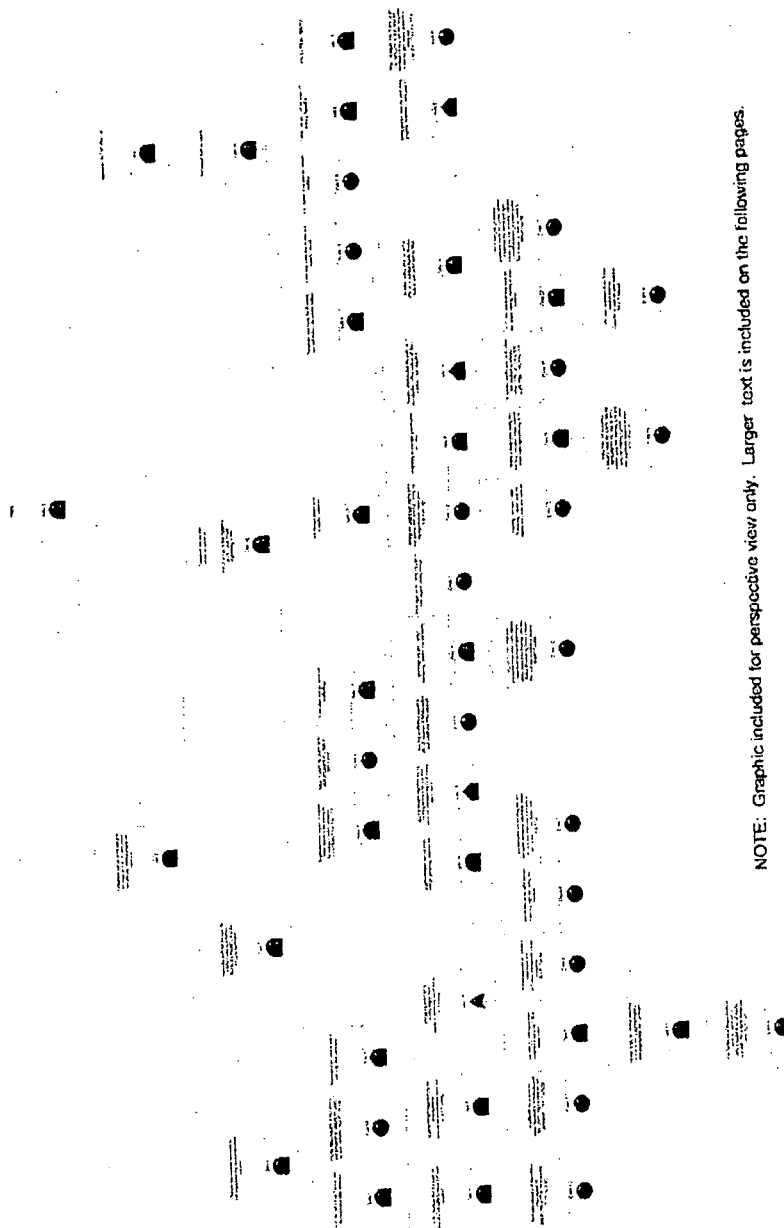
13

File Name E\_CFTree (2006-05-11).RPJ  
Top Gate Name Gate 1

Unavailability  
Unreliability



Building M6-794 Roofing Fatality  
Type A Mishap



NOTE: Graphic included for perspective view only. Larger text is included on the following pages.

**Mishap Investigation Board Findings & Recommendations - Endorsers Comments/Suggestions - Final Approval By Appointing Official**

Mishap Investigation Board Report Findings and Recommendations	OSHA Endorsement	OSMA Endorsement	Chief Engineer Signature/Comment	Final Approval By Appointing Official
<p><b>Root Cause 1 (Section 4.2.1):</b> Oneida was unaware of the OSHA interpretation to classify the work as steel erection (RC1)</p> <p><b>Recommendation (RC1-1):</b> When responding to an RFP and prior to preparing a safety plan, subcontractors should review OSHA regulations and letters of Standard Interpretation to properly classify the work.</p> <ul style="list-style-type: none"> <li>- When roofing jobs are performed, subcontractors are responsible for determining the applicability of 29 CFR 1926.501 (low-sloped roof) and 29 CFR 1926.750 (steel erection) in accordance with OSHA Standards and letters of Standard Interpretation.</li> <li>- Contract language should include information alerting subcontractors that the OSHA Area Office has a compliance assistance specialist available as a resource.</li> </ul>	<p><b>Recommend endorsement with the following changes:</b></p> <p>Second bullet – recommend adding generic contract language stating that the contractor is responsible for being proactive in seeking advice from OSHA.</p> <p>Second bullet – recommend this information is shared at the pre-work meetings, and not in contract language.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p><b>Accept Appointing Official Comment:</b></p> <p><u>Second bullet:</u> Recommend adding generic contract language stating that the contractor is responsible for being proactive in seeking advice from OSHA.</p> <p><u>Second bullet:</u> Recommend this information is shared at the pre-work meetings, and not in contract language.</p> <p><b>Accept OSMA Comment:</b></p> <p><u>Generic:</u> Contract language be placed in the contracts and subcontracts to ensure that contractors review and implement OSHA letters of Standard Interpretation in addition to the OSHA Standards.</p>
<p><b>Root Cause 2 (Section 4.2.2):</b> SOS was unaware of the OSHA interpretation to classify the work as steel erection (RC2)</p> <p><b>Recommendation (RC2-1):</b> Prior to issuing an RFP, the prime contractor should review OSHA regulations and letters of Standard Interpretation to properly classify work.</p> <ul style="list-style-type: none"> <li>- When roofing jobs are performed, contractors are responsible for determining the application and applicability of 29 CFR 1926.501 (low-sloped roof) and 29 CFR 1926.750 (steel erection) in accordance with OSHA Standards and letters of Standard Interpretation.</li> <li>- Contract language should include information alerting subcontractors that the OSHA Area Office has a compliance assistance specialist available as a resource.</li> </ul>	<p><b>Recommend endorsement with the following changes:</b></p> <p>Second bullet – recommend adding generic contract language stating that the contractor is responsible for being proactive in seeking advice from OSHA.</p> <p>Second bullet – recommend this information is shared at the pre-work meetings, and not in contract language.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p><b>Accept Appointing Official Comment:</b></p> <p><u>Second bullet:</u> Recommend adding generic contract language stating that the contractor is responsible for being proactive in seeking advice from OSHA.</p> <p><u>Second bullet:</u> Recommend this information is shared at the pre-work meetings, and not in contract language.</p> <p><b>Accept OSMA Comment:</b></p> <p><u>Generic:</u> Contract language be placed in the contracts and subcontracts to ensure that contractors review and implement OSHA letters of Standard Interpretation in addition to the OSHA Standards.</p> <p>Recommend endorsement as written.</p>
<p><b>Recommendation (RC2-2):</b> NASA/KSC and prime contractors should review current ongoing work involving roofing to ensure proper work classification and compliance with OSHA Standards and letters of Standard Interpretation.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>



# Mishap Investigation Board Findings & Recommendations - Endorsers Comments/Suggestions - Final Approval By Appointing Official

Mishap Investigation Board Report Findings and Recommendations	OSMA Endorsement	CHMO Endorsement	Final Approval By Appointing Official
<p>Root Cause 3 (Section 4.2.3): Oneida did not ensure its superintendent's compliance with the OSHA requirement for fall protection (RC3)</p> <p>Recommendation (RC3-1): Prime contractors should develop a mechanism to ensure that OSHA non-compliance's immediately dangerous to life and health are reported to the subcontractor president/top management.</p>	<p>Recommend endorsement with the following changes:</p> <p>The MIB's recommendation requiring prime contractors to develop a mechanism to ensure OSHA non-compliance are reported to subcontractor management is good, but to ensure carryover to subcontractors, OSMA will lead an effort to develop a corresponding FAR clause.</p>	<p>Recommend endorsement as written.</p>	<p>Accept Appointing Official Comment:</p> <p>That this reporting mechanism be required in the companies S&amp;H Plan that is submitted prior to work beginning.</p> <p>Accept OSMA Comment:</p> <p>To ensure carryover to subcontractors, OSMA will lead an effort to develop a corresponding FAR clause.</p>
<p>Root Cause 4 (Section 4.2.4): SGS did not ensure Oneida's compliance with the OSHA requirement for fall protection (RC4)</p> <p>Recommendation (RC4-1): SGS should develop a mechanism to ensure that OSHA non-compliance immediately dangerous to life and health are reported to the subcontractor president/top management.</p> <p>- Other prime contractors (e.g., USA and Boeing) should develop a similar mechanism to ensure that OSHA non-compliance immediately dangerous to life and health are reported to the subcontractor president/top management.</p> <p>- For construction contracts that NASA/KSC issues, NASA/KSC should develop a similar mechanism to ensure that OSHA non-compliance immediately dangerous to life and health are reported to the contractor president/top management.</p>	<p>Recommend endorsement with the following changes:</p> <p>That this reporting mechanism be required in the companies S&amp;H Plan that is submitted prior to work beginning.</p> <p>Recommend endorsement with the following changes:</p> <p>OSMA requests that in addition to informing the contractor management/ top management of OSHA non-compliance, the contractor should be required (via a contract clause) to inform NASA (monthly or quarterly) of all on-site OSHA non-compliance and the contractors method/process to remediate these non-compliance and further enforce OSHA requirements. OSMA will take appropriate steps to develop such a contract clause in conjunction with the clause to be developed in response to RC3-1 above.</p>	<p>Recommend endorsement as written.</p>	<p>Accept Appointing Official Comment:</p> <p>That this reporting mechanism be required in the companies S&amp;H Plan that is submitted prior to work beginning.</p> <p>Accept Intent of OSMA Comment:</p> <p>Sub-contractor non-compliance should go to the prime contractor, and NASA should then perform audits of the prime contractor's handling of these non-compliance. This method supports performance based contracting whereby the KSC Contractor is responsible and NASA performs audits to ensure compliance.</p> <p>1) Update NASA surveillance/audit process to look at contractor performance on non-compliance with OSHA requirements, and the method they used to oversee their subcontractors.</p> <p>2) Request subcontractor safety data (OSHA non-compliance performance) at Award Fee Board.</p>

# Mishap Investigation Board Findings & Recommendations - Endorsers Comments/Suggestions - Final Approval By Appointing Official

Mishap Investigation Board Report Findings and Recommendations	OSMA Endorsement	CHIMO Endorsement	Chief Engineer Endorsement	Final Approval By Appointing Official
Recommendation (RC4-2): Prime contractor safety specialists should trend noncompliance's and discuss them at the appropriate contractor/subcontractor safety meeting.	Recommend endorsement with the following changes: Recommend adding contract language stating that noncompliance's be trended.	Recommend endorsement as written.	Recommend endorsement as written.	Accept Appointing Official Comment: Recommend adding contract language stating that noncompliance's be trended.
Recommendation (RC4-3): For construction contracts that NASA/KSC issues, NASA/KSC should trend noncompliance's and discuss them at the appropriate contractor safety meeting.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.
Root Cause 5 (Section 4.2.5): NASA/KSC fall protection practices follow the OSHA-defined standards for low-sloped roofs, which allow the Warning Line and Safety Monitoring System rather than requiring a physical-restraint system. (RC5)	Recommend endorsement as written.			
Recommendation (RC5-1): NASA/KSC should develop and implement a fall protection policy and program for low-sloped roofing work that is more stringent than the OSHA standard and requires the use of physical restraints when working within 6 ft of the edge. The use of warning lines and safety monitors or other nonphysical-restraint systems should be reserved for special circumstances after review and approval through a NASA/KSC formalized variance process.	It is also not clear that the MIB's proposed recommendation will be effective in preventing recurrence, since the cause of this mishap was not lack of effective requirements, but that the requirements were not implemented. Therefore implementation of this MIB recommendation is more stringent than required and should remain a Center decision.	Recommend endorsement as written.	The report discusses that neither the prime nor subcontractors were aware of a specific, 8 Nov 2002, letter of Standard Interpretation that classified the work-site as "steep erection" requiring physical constraints rather than just a "low slope roof" requiring minimal protection. It is not clear that the recommendation addresses any practices beyond "low slope roof" nor that it covers omission or misclassification. Given that two contractors missed this particular requirement which imposes more stringent measures, this recommendation should be extended to specifically address all KSC and NASA fall protection practices where this omission could have also occurred. We believe the OSMA Endorsement letter recommendation to add contract language to ensure that all letters of Standard Interpretation are reviewed by contractors and subcontractors will help for future contracts. Until this recommendation is effected in new contracts, we believe an additional safety advisory alert should be issued by OSMA for all Centers to review their ongoing or planned projects that may also have missed this letter of Standard Interpretation.	Accept Chief Engineer Comment: Recommendation should be extended to specifically address all KSC and NASA fall protection practices where this omission could have also occurred. We believe the OSMA Endorsement letter recommendation to add contract language to ensure that all letters of Standard Interpretation are reviewed by contractors and subcontractors will help for future contracts. Until this recommendation is effected in new contracts, we believe an additional safety advisory alert should be issued by OSMA for all Centers to review their ongoing or planned projects that may also have missed this letter of Standard Interpretation.
Recommendation (RC5-2): A Centerwide fall protection team (civil servants and contractors) should be formed to examine issues (e.g., standardization across contractors, variance processing, retrofitting of existing facilities) arising from the implementation of a new, more stringent fall protection policy and program.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.

# Mishap Investigation Board Findings & Recommendations - Endorsers Comments/Suggestions - Final Approval By Appointing Official

Mishap Investigation Board Report Findings and Recommendations	OSMA Endorsement	OSMA Endorsement	OSMA Endorsement	Final Approval By Appointing Official
Contributing Factor 1 (Section 4.3.1): Superintendent helped move the roofing panel while acting as the safety monitor (CoF1) Note: This contributing factor was analyzed further and the result led to Root Causes 3 and 4.	N/A	N/A	N/A	N/A
Contributing Factor 2 (Section 4.3.2): Superintendent did not stop the job and seek additional personnel when two workers were not sufficient (CoF2).	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.
Recommendation (CoF2-1): Prime contractors should investigate providing incentives to subcontractors for safe work, similar to how NASA/KSC provides monetary award for safety performance to its construction contractors.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.
Contributing Factor 3 (Section 4.3.3): Temporary anchorage points were not required by OSHA, NASA, KSC or contractors (CoF3).	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.
Recommendation (CoF3-1): A Centerwide fall protection team (civil servants and contractors) should be formed to examine issues (e.g. use of temporary anchorage points, standardization across contractors, variance processing, retrofitting of existing facilities) arising from the implementation of a fall protection policy and program.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.
Contributing Factor 4 (Section 4.3.4): While not legally intoxicated under Florida's Driving Standard, the deceased was under the influence of alcohol and tested positive for marijuana (CoF4).	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.
Recommendation (CoF4-1): NASA Headquarters should evaluate the requirements of the NASA Drug Free Work Place Program and the NASA FAR Supplement, section on Drug-Free Workplace for contractors, to determine whether they are adequate to protect the civil-service and contractor workforce.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.
Failed Barrier 1 (Section 4.4.1): Superintendent did not use the Warning Line and Safety Monitoring System correctly (FB1) See Recommendation RC5-1.	N/A	N/A	N/A	N/A

# Mishap Investigation Board Findings & Recommendations - Endorsers Comments/Suggestions - Final Approval By Appointing Official

Mishap Investigation Board Report Findings and Recommendations	OSMA Endorsement	CHMIG Endorsement	Chief Engineer Endorsement	Final Approval By Appointing Official
<p>Significant Observation 1 (Section 4.5.1): Oneida did not maintain a current list of employees who were working on the job site (O1)</p> <p>Recommendation (O1-1): SGS should ensure that its subcontractors maintain a current list of all employees working on the job site.</p> <p>- Employee lists should be kept at job sites for review by SGS. Subcontractor site supervisors should update employee lists as new employees come onto a job site.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Accept Appointing Official Comment: That SGS accomplish this by adding appropriate contract language.</p>
<p>Significant Observation 2 (Section 4.5.2): Oneida did not conduct, or did not document, all weekly safety meetings (O2)</p> <p>Recommendation (O2-1): SGS should ensure that subcontractor site superintendents comply with safety meeting and documentation requirements as set forth in their contracts.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>
<p>Significant Observation 3 (Section 4.5.3): Oneida provided no evidence that either the deceased or the other Oneida worker was trained by a competent person qualified in 29 CFR 1926, Subpart M, Fall Protection. Therefore, the training of the deceased and the other Oneida worker was deficient (O3)</p> <p>Recommendation (O3-1): SGS should ensure that Oneida retrain all its employees who perform work for KSC in required elements of fall protection. Proof of training by a competent and qualified person should be provided.</p> <p>Recommendation (O3-2): A Centerwide fall protection team should develop minimum standards or elements of fall protection training for use by KSC construction contractors and subcontractors as they develop their training requirements.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>
<p>Significant Observation 4 (Section 4.5.4): The training certification provided by Oneida was not signed by the trainer or the employer, so it was in technical violation of 29 CFR 1926.503(b)(1), (O4)</p> <p>Recommendation (O4-1): SGS should evaluate methods of enforcing the 29 CFR 1926.503(b)(1) requirement for its subcontractors.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p>

# Mishap Investigation Board Findings & Recommendations - Endorsers Comments/Suggestions - Final Approval By Appointing Official

Mishap Investigation Board Report Findings and Recommendations	OSMA Endorsement	SGS Endorsement	SGS Endorsement	Final Approval By Appointing Official
<p><b>Significant Observation 5 (Section 4.5.5):</b> While KSC fall protection training was, for the most part, adequate for construction workers, it was insufficient for specialized training for competent or qualified persons and inspector training (O5).</p> <p><b>Recommendation (O5-1):</b> A Centerwide fall protection team should evaluate KSC fall protection training programs to ensure that training is appropriate and adequate to train personnel to be "competent and qualified" as defined in 29 CFR 1926.32.</p> <p><b>Significant Observation 6 (Section 4.5.6):</b> Contractors and subcontractors were not required to inform NASA of all on-center worksite OSHA noncompliance's (O6).</p> <p><b>Recommendation (O6-1):</b> NASA/KSC should determine if the existing policy, which does not require NASA/KSC to be informed of all worksite safety noncompliance's, is adequate.</p> <p><b>Significant Observation 7 (Section 4.5.7):</b> Inadequate coordination within SGS resulted in Oneida working without the knowledge of SGS Safety.</p> <p><b>Recommendation (O7-1):</b> SGS should ensure proper coordination among all elements of SGS and subcontractors prior to start of work (i.e., before permission to return to work is granted to subcontractors, confirmation should be obtained from each SGS organization required to monitor subcontractor performance).</p> <p><b>Significant Observation 8 (Section 4.5.8):</b> Permanent anchorage points were not added anytime after the initial construction of Building M6-794, and KSC policy did not require their installation (O8).</p> <p><b>Recommendation (O8-1):</b> A Centerwide fall protection team (civil servants and contractors) should consider the policy of adding permanent anchorage points on new construction projects at KSC and retrofitting existing facility roofs with permanent fall protection systems based on a hierarchy of need (e.g., roof access frequency, presented hazards).</p>	<p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p>	<p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p> <p>Recommend endorsement as written.</p>

# Mishap Investigation Board Findings & Recommendations - Endorsers Comments/Suggestions - Final Approval By Appointing Official

Mishap Investigation Board Report Findings and Recommendations	OSMA Endorsement	OSMA Endorsement	OSMA Endorsement	Final Approval By Appointing Official
<p>Significant Observation 9 (Section 4.5.9): Other than OSHA minimum standards, no single, standardized fall protection policy exists across all NASA Centers or operating locations (09).</p> <p>Recommendation (09-1): NASA's Office of Safety and Mission Assurance (OSMA) should take the lead in convening an inter-center team of safety and fall protection experts to make recommendations concerning a uniform fall protection policy for the Agency.</p>	Recommend endorsement as written.	OSMA believes that NASA does have a single standard fall protection policy for the Agency. NASA's policy is to comply with OSHA requirements for fall protection. OSMA does not concur that an Agency level team is needed to define a implement fall protection policy that exceeds OSHA requirements. Each Center can make an individual determination whether exceeding OSHA requirements is feasible and achievable for their sites.	Recommend endorsement as written.	<p>Accept OSMA Comment:</p> <p>The basis of this recommendation was that the MIB recognized that NASA did not have one fall protection policy, and that simple compliance with OSHA may in fact expose employees to a fall hazard and yet still be OSHA compliant. KSC will accept the OSMA comment that "each Center make an individual determination whether exceeding OSHA requirements is feasible and achievable for their sites". However, KSC will implement a fall protection policy which goes beyond mere OSHA compliance in order to protect our NASA and contractor employees, and KSC will make this policy available to all NASA Centers.</p>
<p>Significant Observation 10 (Section 4.5.10): Drug and alcohol testing was not performed on Onecida workers involved in the mishap (010).</p> <p>Recommendation (010-1): NASA Headquarters should revise the NASA Drug Free Work Place Program (NPR 3792.1A, NASA Plan for a Drug-Free Workplace, for civil servants; and the NASA FAR supplement section on Drug-Free Workplace for contractors) to include post mishap drug and alcohol testing for all contractor, subcontractor, and Government employees involved in Type A and Type B mishaps.</p> <p>Recommendation (010-2): The Center Safety Office should develop a checklist of activities for the Incident Response Team (IRT) to ensure all critical elements of a mishap investigation, including testing for drugs and alcohol in a Type A or Type B mishap, are accomplished.</p>	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.

# Mishap Investigation Board Findings & Recommendations - Endorsers Comments/Suggestions - Final Approval By Appointing Official

Mishap Investigation Board Report Findings and Recommendations	OSMA Endorsement	OSMA Endorsement	OSMA Endorsement	Final Approval By Appointing Official
<p><b>Significant Observation 11 (Section 4.5.11):</b> Contract clause flowdown to the subcontractor was not a contributing factor to the mishap (O11). Recommendation (O11-1): None. The SGS Prime Contract NAS10-99001 contained all pertinent safety clauses. The SGS safety clauses flowed down appropriately to the Oneida subcontract. Contract clause flowdown was not considered a contributing factor to the mishap.</p>	Recommend endorsement as written.	Recommend endorsement as written.	Recommend endorsement as written.	
<p><b>Significant Observation 12 (Section 4.5.12):</b> Behaviors identified in mishaps can be used to study and improve the KSC safety culture (O12). Recommendation (O12-1): A NASA/KSC team should identify a consistent method of categorizing behavioral contributing factors to mishaps, considering the various models used at KSC and in industry. This can be used for two purposes: - Recent mishaps: Identify similar at-risk behaviors that led to recent mishaps and develop a plan to reduce these behaviors at KSC. This may have long-term effects on the KSC safety culture. - Future mishaps: Use this method of categorizing behavioral contributing factors in future mishaps to improve trending and reduce at-risk behaviors. Ensure that future mishap boards consider cultural issues from the beginning by identifying how to include culture in mishap investigation reports. Define specifically what should and should not be included in mishap reports regarding culture.</p>	Recommend endorsement as written.	OSMA believes that existing Agency taxonomies, e.g., Incident Analysis Tool-Modified (IAT-M) or NASA Root Cause Analysis Tool are both suitable for the task of including culture in mishap investigation reports. Rather than spending Agency resources creating an additional taxonomy, OSMA requests that KSC use one of these existing taxonomies, or cognitive fuzzy logic (e.g., via the Starlight Software) to identify trends across Center mishaps and generate recommendations to reduce at risk behaviors.	Recommend endorsement as written.	Accept OSMA Comment: OSMA requests that KSC use one of these existing taxonomies, or cognitive fuzzy logic (e.g., via the Starlight Software) to identify trends across Center mishaps and generate recommendations to reduce at risk behaviors.

# Mishap Investigation Board Findings & Recommendations - Endorsers Comments/Suggestions - Final Approval By Appointing Official

Mishap Investigation Board Report Findings and Recommendations	Mishap Investigation Board Findings and Recommendations	OSHA Endorsement	OSHA Comments/Suggestions	Final Approval By Appointing Official
<p><b>Miscellaneous Comments</b></p> <p>Executive Summary, Root Cause 2, Recommendation RC2-1 states, "Prior to issuing an RFP, the prime contractor should review OSHA Standards and letters of Standard Interpretations to properly classify work."</p>	<p>Recognition of differences: While the Summary of Findings and Recommendations, Sec 4.2.2, RC2-1 states, "Prior to issuing an RFP, the prime contractor should review OSHA regulations and letters of Standard Interpretation to properly classify work."</p> <ul style="list-style-type: none"> <li>- When roofing jobs are performed, contractors are responsible for determining the application and applicability of 29CFR 1926.501 (low-sloped roof) and 29CFR 1926.750 (steel erection) in accordance with OSHA Standards and letters of Standard Interpretation.</li> <li>- Contract language should include information alerting subcontractors that the OSHA Area Office has a compliance assistance specialist available as a resource."</li> </ul>			<p>No action required:</p> <p>Recognition of differences between the "Executive Summary" section and the "Findings and Recommendations" section.</p>
			<p>Under "Proximate Cause 2: The deceased fell from the roof" on page v (Executive Summary) and on page 47 (4.1.2) the report states: "Evidence shows that the deceased either tripped or stumbled prior to falling off the roof, rather than stepped off the roof." The evidence in support of this conclusion was not identified in the report.</p>	<p>No action required:</p> <p>While this conclusion may not have been clear in the report, the evidence in support of this conclusion was based on the testimony of the eye witness.</p>
			<p>There was no mention (other than the drug and alcohol test) of medical conditions or findings. I assume the deceased's past medical information, ER record, and any autopsy findings were not available to the Mishap Investigation Board, and no conclusions as to other possible predisposing medical factors could be drawn from those sources.</p>	<p>No action required:</p> <p>The autopsy report was obtained and reviewed by the MIB as stipulated in the Mishap Report. However, the deceased's past medical information, ER record, etc., were not reviewed as they were protected by the Health Insurance Portability and Accountability Act (HIPAA), Medical Privacy - National Standards to Protect the Privacy of Personal Health Information, and not available to the MIB.</p>